PCTEST ENGINEERING LABORATORY, INC.
7185 Oakland Mills Road, Columbia, MD 21046 USA
Tel. +1.410.290.6652 / Fax +1.410.290.6654
http://www.pctestlab.com


# SAR EVALUATION REPORT

**Applicant Name:**
Samsung Electronics, Co. Ltd.
129, Samsung-ro, Maetan dong,
Yeongtong-gu, Suwon-si
Gyeonggi-do 443-742, Korea

**Date of Testing:**
07/29/13 - 08/05/13
**Test Site/Location:**
PCTEST Lab, Columbia, MD, USA
**Document Serial No.:**
0Y1307261450.A3L

**FCC ID:** **A3LSGHI337**

**APPLICANT:** **SAMSUNG ELECTRONICS, CO. LTD.**

**DUT Type:** Portable Handset
**Application Type:** Class II Permissive Change
**FCC Rule Part(s):** CFR §2.1093
**Model(s):** SGH-I337
**Serial Number(s):** FK-193-A [Pre-production]
**Permissive Change(s):** WIFI 5GHz FEM Vendor Change
**Date of Original Certification:** April 1, 2013

| Equipment Class | Band & Mode | Tx Frequency | Measured Conducted Power [dBm] | SAR | | |
|---|---|---|---|---|---|---|
| | | | | 1 gm Head (W/kg) | 1 gm Body-Worn (W/kg) | 1 gm Wireless Router (W/kg) |
| DTS | 5.8 GHz WLAN | 5745 - 5825 MHz | 12.51 | 0.24 | 0.12 | 0.23 |
| NII | 5.2 GHz WLAN | 5180 - 5240 MHz | 12.78 | 0.41 | 0.82 | |
| NII | 5.3 GHz WLAN | 5260 - 5320 MHz | 13.08 | 0.40 | 0.73 | |
| NII | 5.5 GHz WLAN | 5500 - 5700 MHz | 13.18 | 0.16 | 0.32 | |
| **Simultaneous SAR per KDB 690783 D01v01r02:** | | | | 1.01 | 1.58 | 1.01 |

Note: Powers in the above table represent output powers for the SAR test configurations and may not represent the highest output powers for all configurations for each mode.

The table above shows WIFI 5GHz SAR Test Data evaluated for current test report. Please refer to RF Exposure Technical Report S/N 0Y1303140498-R1.A3L for original compliance evaluation.

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in Section 1.9 of this report; for North American frequency bands only.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.

Randy Ortanez
President

ACCREDITED
TESTING LABORATORY
CERTIFICATE #2041.01

# T A B L E   O F   C O N T E N T S

# 1 DEVICE UNDER TEST

## 1.1 Device Overview

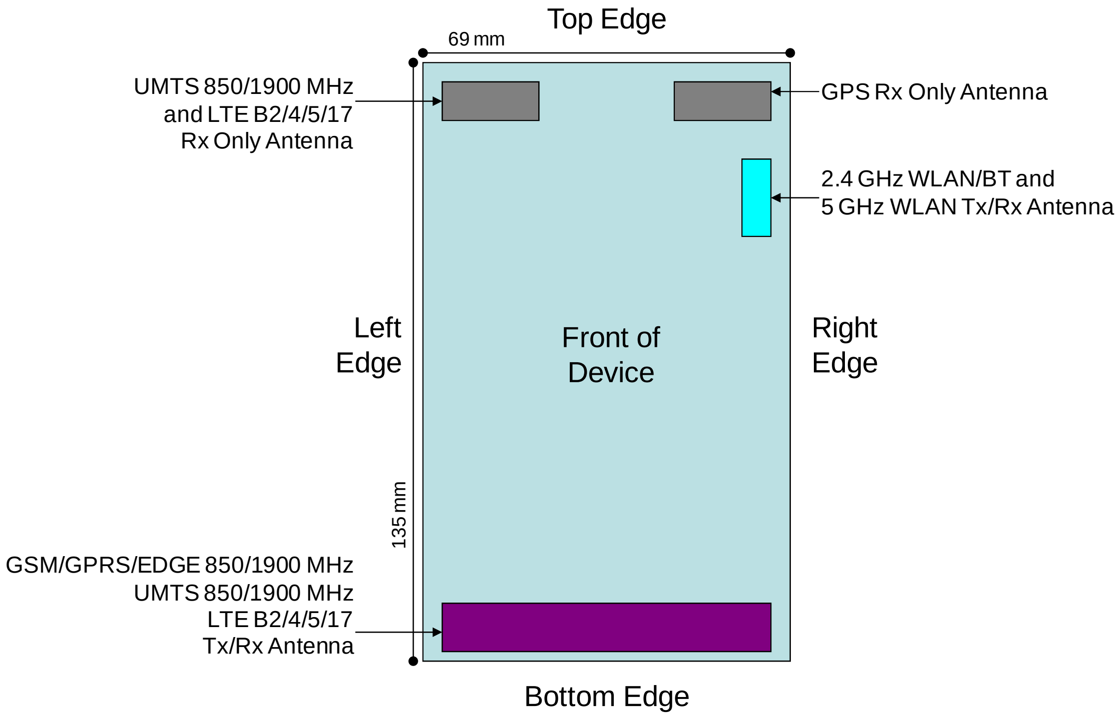
| Band & Mode | Operating Modes | Tx Frequency |
|---|---|---|
| GSM/GPRS/EDGE 850 | Voice/Data | 824.20 - 848.80 MHz |
| UMTS 850 | Voice/Data | 826.40 - 846.60 MHz |
| GSM/GPRS/EDGE 1900 | Voice/Data | 1850.20 - 1909.80 MHz |
| UMTS 1900 | Voice/Data | 1852.4 - 1907.6 MHz |
| LTE Band 17 | Data | 706.5 - 713.5 MHz |
| LTE Band 5 (Cell) | Data | 826.5 - 846.5 MHz |
| LTE Band 4 (AWS) | Data | 1712.5 - 1752.5 MHz |
| LTE Band 2 (PCS) | Data | 1852.5 - 1907.5 MHz |
| 2.4 GHz WLAN | Data | 2412 - 2462 MHz |
| 5.8 GHz WLAN | Data | 5745 - 5825 MHz |
| 5.2 GHz WLAN | Data | 5180 - 5240 MHz |
| 5.3 GHz WLAN | Data | 5260 - 5320 MHz |
| 5.5 GHz WLAN | Data | 5500 - 5700 MHz |
| Bluetooth | Data | 2402 - 2480 MHz |
| NFC | Data | 13.56 MHz |

## 1.2 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v05.

| Mode / Band | | Modulated Average (dBm) |
|---|---|---|
| IEEE 802.11b (2.4 GHz) | Maximum | **17.0** |
| | Nominal | **16.5** |
| IEEE 802.11g (2.4 GHz) | Maximum | **15.0** |
| | Nominal | **14.5** |
| IEEE 802.11n (2.4 GHz) | Maximum | **14.0** |
| | Nominal | **13.5** |
| IEEE 802.11a (5 GHz) | Maximum | **13.5** |
| | Nominal | **13.0** |
| IEEE 802.11n (5 GHz) | Maximum | **13.5** |
| | Nominal | **13.0** |
| IEEE 802.11ac (5 GHz) | Maximum | **13.0** |
| | Nominal | **12.5** |
| Bluetooth | Maximum | **10.0** |
| | Nominal | **9.5** |

## 1.3 DUT Antenna Locations




Note: Exact antenna dimensions and separation distances are shown in the Technical Descriptions in the FCC Filing.

**Figure 1-1**
**DUT Antenna Locations**

**Table 1-1**
**Wireless Router Sides for SAR Testing**

| Mode | Back | Front | Top | Bottom | Right | Left |
|---|---|---|---|---|---|---|
| 5.8 GHz WLAN | Yes | Yes | Yes | No | Yes | No |

Note: Particular DUT edges were not required to be evaluated for Wireless Router SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06v01 guidance, page 2. This device supports 5 GHz Hotspot in the 5.8 GHz band only.

## 1.4 Near Field Communications (NFC) Antenna

This DUT has NFC operations. The NFC antenna is integrated into the specialized battery. The SAR tests were performed with the specialized battery (model: **B600BU**).

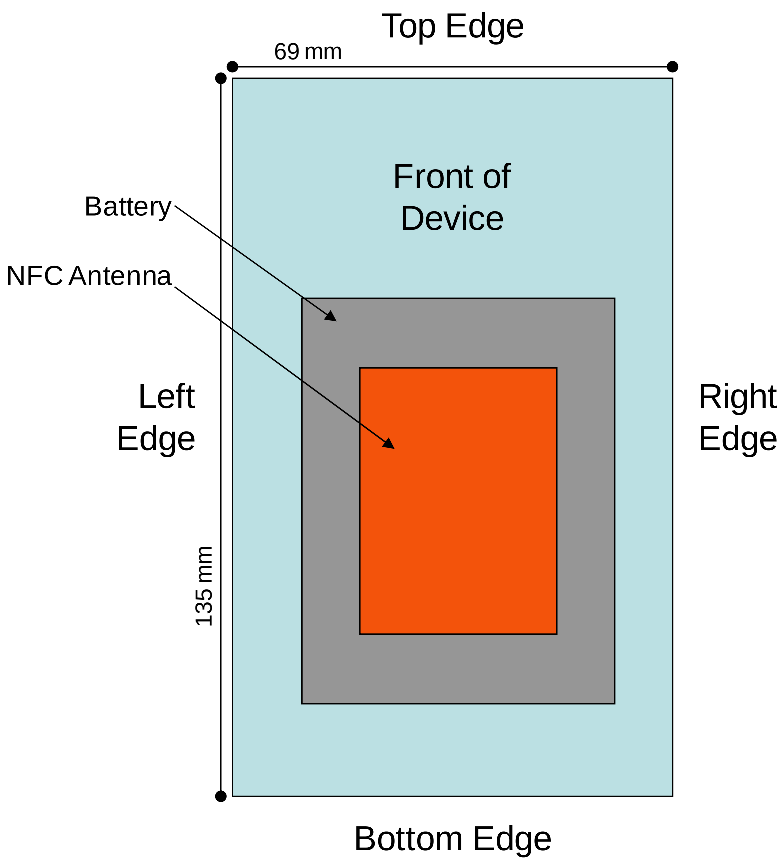



**Figure 1-2**
**NFC Antenna Locations**

## 1.5 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D05v01, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds.
This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v05 3) procedures.


**Figure 1-3**
**Simultaneous Transmission Paths**

**Table 1-2**
**Simultaneous Transmission Scenarios**

| No. | Capable Transmit Configurations | Head | Body-Worn Accessory | Hotspot | Note |
|---|---|---|---|---|---|
| | | IEEE 1528, Supplement C | Supplement C | FCC KDB 941225 D06 Edges/Sides | |
| 1 | GSM 850/1900 MHz Voice + Wifi 2.4 GHz | Yes | Yes | N/A | |
| 2 | 850/1900 MHz UMTS Voice + Wifi 2.4 GHz | Yes | Yes | N/A | |
| 3 | 850/1900 MHz GPRS/EDGE Data + Wifi 2.4 GHz | N/A | N/A | Yes | 2G Hotspot |
| 4 | 850/1900 MHz UMTS Data + Wifi 2.4 Ghz | Yes* | Yes* | Yes | 3G Hotspot |
| 5 | LTE Band 17/5/4/2 Data + Wifi 2.4 GHz | Yes* | Yes* | Yes | 4G Hotspot |
| 6 | GSM 850/1900 MHz Voice + Wifi 5 GHz | Yes | Yes | N/A | |
| 7 | 850/1900 MHz UMTS Voice + Wifi 5 GHz | Yes | Yes | N/A | |
| 8 | GSM Voice + 2.4 GHz Bluetooth | N/A | Yes | N/A | |
| 9 | UMTS Voice + 2.4 GHz Bluetooth | N/A | Yes | N/A | |
| 10 | LTE + 2.4 GHz Bluetooth | N/A | Yes* | N/A | |
| 11 | 850/1900 MHz GPRS/EDGE Data + Wifi 5 GHz | N/A | N/A | Yes | WIFI Direct |
| 12 | 850/1900 MHz UMTS Data + Wifi 5 Ghz | Yes* | Yes* | Yes | WIFI Direct |
| 13 | LTE Band 17/5/4/2 Data + Wifi 5 GHz | Yes* | Yes* | Yes | WIFI Direct |
| 14 | All Voice + LTE | N/A | N/A | N/A | Not supported by H/W |
| 15 | All Voice + Wifi + LTE | N/A | N/A | N/A | Not supported by H/W |

(*) = for VOIP 3rd party applications possibly installed and used by the end-user

When the user utilizes multiple services in UMTS 3G mode it uses multi-Radio Access Bearer or multi-RAB. The power control is based on a physical control channel (Dedicated Physical Control Channel [DPCCH]) and power control will be adjusted to meet the needs of both services. Therefore, the UMTS+WLAN scenario also represents the UMTS Voice/DATA + WLAN Hotspot scenario.

Per the manufacturer, WIFI Direct is not expected to be used in conjunction with a held-to-ear or body-worn accessory voice call. Therefore, there are no new simultaneous transmission scenarios involving WIFI direct.

## 1.6 Wireless Charging Cover

This DUT may be used with a standard battery cover or with an optional wireless charging battery cover. Per FCC KDB Publication 648474 D04v01r01, SAR was measured using the standard battery cover and then repeated with the wireless charging battery cover for the highest reported SAR for each wireless technology, frequency band, operating mode, and exposure condition. No other additional test with wireless charging cover was required since all reported SAR were less than 1.2 W/kg.

## 1.7 SAR Test Exclusions Applied

Per the FCC change document for this device, the licensed transmitter and 2.4GHz WIFI/Bluetooth modes remain the same as the original certified device. Therefore, no additional SAR evaluations were required for these technologies.

This device supports 20 MHz and 40 MHz Bandwidths for IEEE 802.11n for 5 GHz WIFI only. IEEE 802.11n was not evaluated for SAR since the average output power of 20 MHz and 40 MHz bandwidths was not more than 0.25 dB higher than the average output power of IEEE 802.11a.

This device supports IEEE 802.11ac with the following features:

a) Up to 80 MHz Bandwidth only
b) No aggregate channel configurations
c) 1 Tx antenna output
d) 256 QAM is supported
e) No new 5 GHz channels

Full SAR tests for all IEEE 802.11ac configurations were not required because the average output power was not more than 0.25 dB higher than IEEE 802.11a mode. IEEE 802.11ac was evaluated for the highest IEEE 802.11a configuration in each 5 GHz band and exposure condition.

This device supports 5 GHz Hotspot in the 5.8 GHz band only. Therefore, no other 5 GHz bands were evaluated for hotspot configurations.

## 1.8 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

## 1.9 Guidance Applied

- FCC OET Bulletin 65 Supplement C [June 2001]
- IEEE 1528-2003
- FCC KDB Publication 941225 D06 (Hotspot)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v05 (General SAR Guidance)
- FCC KDB Publication 865664 D01-D02 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 648474 D03-D04 (Wireless Charging Cover)
- April 2013 TCB Workshop Notes (IEEE 802.11ac)

.

# 2 INTRODUCTION

The FCC and Industry Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [24]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

## 2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density ($\rho$). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 2-1).

**Equation 2-1**
**SAR Mathematical Equation**

$$SAR = \frac{d}{dt}\left(\frac{dU}{dm}\right) = \frac{d}{dt}\left(\frac{dU}{\rho dv}\right)$$

**SAR is expressed in units of Watts per Kilogram (W/kg).**

$$SAR = \frac{\sigma \cdot E^2}{\rho}$$

where:

$\sigma$ = conductivity of the tissue-simulating material (S/m)
$\rho$ = mass density of the tissue-simulating material ($kg/m^3$)
E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

# 3 DOSIMETRIC ASSESSMENT

## 3.1 Measurement Procedure

The evaluation was performed using the following procedure:

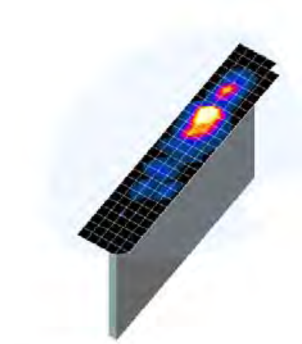


**Figure 3-1**
**Sample SAR Area Scan**

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01 (See Table 3-1).
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01 (See Table 3-1). On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):

   a. The data was extrapolated to the surface of the outer-shell of the phantom. The combined distance extrapolated was the combined distance from the center of the dipoles 2.7mm away from the tip of the probe housing plus the 1.2 mm distance between the surface and the lowest measuring point. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).

   b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.

   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

**Table 3-1**
**Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01**

| Frequency | Maximum Area Scan Resolution (mm) ($\Delta x_{area}$, $\Delta y_{area}$) | Maximum Zoom Scan Resolution (mm) ($\Delta x_{zoom}$, $\Delta y_{zoom}$) | Maximum Zoom Scan Spatial Resolution (mm) | | | Minimum Zoom Scan Volume (mm) (x,y,z) |
|---|---|---|---|---|---|---|
| | | | Uniform Grid | Graded Grid | | |
| | | | $\Delta z_{zoom}(n)$ | $\Delta z_{zoom}(1)$* | $\Delta z_{zoom}(n>1)$* | |
| ≤ 2 GHz | ≤ 15 | ≤ 8 | ≤ 5 | ≤ 4 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 30 |
| 2-3 GHz | ≤ 12 | ≤ 5 | ≤ 5 | ≤ 4 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 30 |
| 3-4 GHz | ≤ 12 | ≤ 5 | ≤ 4 | ≤ 3 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 28 |
| 4-5 GHz | ≤ 10 | ≤ 4 | ≤ 3 | ≤ 2.5 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 25 |
| 5-6 GHz | ≤ 10 | ≤ 4 | ≤ 2 | ≤ 2 | ≤ 1.5*$\Delta z_{zoom}(n-1)$ | ≥ 22 |

# 4 DEFINITION OF REFERENCE POINTS

## 4.1 EAR REFERENCE POINT

Figure 4-2 shows the front, back and side views of the SAM Twin Phantom. The point "M" is the reference point for the center of the mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERP is 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 4-1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 4-1). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].

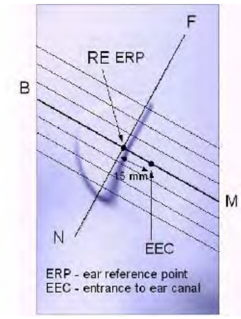



**Figure 4-1**
**Close-Up Side view of ERP**

## 4.2 HANDSET REFERENCE POINTS

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the "test device reference point" located along the "vertical centerline" on the front of the device aligned to the "ear reference point" (See Figure 4-3). The "test device reference point" was than located at the same level as the center of the ear reference point. The test device was positioned so that the "vertical centerline" was bisecting the front surface of the handset at its top and bottom edges, positioning the "ear reference point" on the outer surface of the both the left and right head phantoms on the ear reference point.


**Figure 4-2**
**Front, back and side view of SAM Twin Phantom**

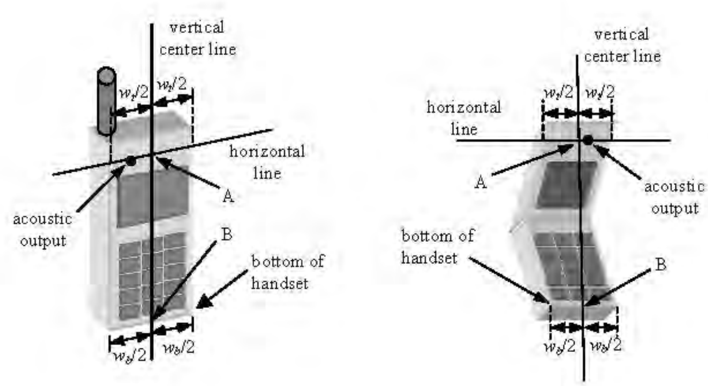



**Figure 4-3**
**Handset Vertical Center & Horizontal Line Reference Points**

# 5 TEST CONFIGURATION POSITIONS FOR HANDSETS

## 5.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02.

## 5.2 Positioning for Cheek

1. The test device was positioned with the device close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 5-1), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.


**Figure 5-1 Front, Side and Top View of Cheek Position**

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.
3. While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (reference plane).
4. The phone was then rotated around the vertical centerline until the phone (horizontal line) was symmetrical was respect to the line NF.
5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the device contact with the ear, the device was rotated about the NF line until any point on the handset made contact with a phantom point below the ear (cheek) (See Figure 5-2).

## 5.3 Positioning for Ear / 15º Tilt

With the test device aligned in the "Cheek Position":

1. While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15degrees.
2. The phone was then rotated around the horizontal line by 15 degrees.
3. While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the handset touched the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. The tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head (see Figure 5-2).

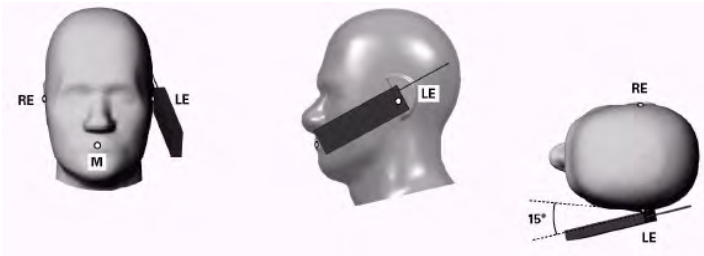



Figure 5-2 Front, Side and Top View of Ear/15º Tilt Position

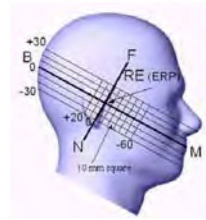



**Figure 5-3**
**Side view w/ relevant markings**

## 5.4 SAR Evaluations near the Mouth/Jaw Regions of the SAM Phantom

Antennas located near the bottom of a phone may require SAR measurements around the mouth and jaw regions of the SAM head phantom. This typically applies to clam-shell style phones that are generally longer in the unfolded normal use positions or to certain older style long rectangular phones.

Under these circumstances, the following procedures apply, adopted from the FCC guidance on SAR handsets document FCC KDB Publication 648474 D04_v01. The SAR required in these regions of SAM should be measured using a flat phantom. The phone should be positioned with a separation distance of 4 mm between the ear reference point (ERP) and the outer surface of the flat phantom shell. While maintaining this distance at the ERP location, the low (bottom) edge of the phone should be lowered from the phantom to establish the same separation distance between the peak SAR location identified by the truncated partial SAR distribution measured with the SAM phantom. The distance from the peak SAR location to the phone is determined by the straight line passing perpendicularly through the phantom surface. When it is not feasible to maintain 4 mm separation at the ERP while also establishing the required separation at the peak SAR location, the top edge of the phone will be allowed to touch the phantom with a separation < 4 mm at the ERP. The phone should not be tilted to the left or right while placed in this inclined position to the flat phantom.

The latest IEEE 1528 committee developments propose the usage of a tilted phantom when the antenna of the phone is mounted at the bottom or in all cases the peak absorption is in the chin region. Both SAM heads of the TwinSAM-Chin20 are rotated 20 degrees around the NF line. Each head can be removed individually from the table for emptying and cleaning.

**Figure 5-4 Twin SAM Chin20**

## 5.5 Body-Worn Accessory Configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 5-5). Per FCC KDB Publication 648474 D04v01, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01v05 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

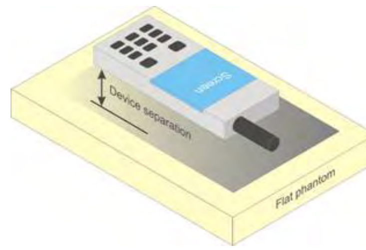



**Figure 5-5**
**Sample Body-Worn Diagram**

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented. Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

## 5.6 Extremity Exposure Configurations

Devices that are designed or intended for use on extremities or mainly operated in extremity only exposure conditions; i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation. When the device also operates in close proximity to the user's body, SAR compliance for the body is also required. The 1-g body and 10-g extremity SAR Exclusion Thresholds found in KDB Publication 44798 D01v05 should be applied to determine SAR test requirements.

Per KDB Publication 44798 D01v05, Cell phones (handsets) are not normally designed to be used on extremities or operated in extremity only exposure conditions. The maximum output power levels of handsets generally do not require extremity SAR testing to show compliance. Therefore, extremity SAR was not evaluated for this device.

## 5.7 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 v01 where SAR test considerations for handsets (L x W ≥ 9 cm x 5 cm) are based on a composite test separation distance of 10 mm from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v05 publication procedures. The "Portable Hotspot" feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

# 6 RF EXPOSURE LIMITS

## 6.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

## 6.2 Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

**Table 6-1**
**SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6**

| HUMAN EXPOSURE LIMITS | | |
|---|---|---|
| | UNCONTROLLED ENVIRONMENT<br>*General Population*<br>(W/kg) or (mW/g) | CONTROLLED ENVIRONMENT<br>*Occupational*<br>(W/kg) or (mW/g) |
| **Peak Spatial Average SAR**<br>Head | 1.6 | 8.0 |
| **Whole Body SAR** | 0.08 | 0.4 |
| **Peak Spatial Average SAR**<br>Hands, Feet, Ankle, Wrists, etc. | 4.0 | 20 |

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

# 7 FCC MEASUREMENT PROCEDURES

## 7.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r02.

## 7.2 SAR Testing with 802.11 Transmitters

Normal network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g/n /ac transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 D01v01r02 for more details.

### 7.2.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

### 7.2.2 Frequency Channel Configurations [27]

For 5 GHz, the highest average RF output power channel across the default test channels at the lowest data rate was selected for SAR evaluation in 802.11a. When the adjacent channels are higher in power then the default channels, these “required channels” were considered instead of the default channels for SAR testing. 802.11n modes and higher data rates for 802.11a/n were evaluated only if the respective mode was 0.25 dB or higher than the 802.11a mode. 802.11ac SAR was evaluated for highest 802.11a configuration in each 5 GHz band and each exposure condition. 802.11ac modes were additionally evaluated for SAR if the output power for the respective mode was more than 0.25 dB higher than powers of 802.11a modes.

If the maximum extrapolated peak SAR of the zoom scan for the highest output channel was less than 1.6 W/kg and if the 1g averaged SAR was less than 0.8 W/kg, SAR testing was not required for the other test channels in the band.

# 8 RF CONDUCTED POWERS

## 8.1 WLAN Conducted Powers

**Table 8-1**
**IEEE 802.11a Average RF Power**

| Mode | Freq | Channel | 802.11a (5GHz) Conducted Power [dBm] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | |
| | [MHz] | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 802.11a | 5180 | 36* | **12.57** | 12.47 | 12.51 | 12.47 | 12.45 | 12.46 | 12.58 | 12.34 |
| 802.11a | 5200 | 40 | 12.40 | 12.36 | 12.40 | 12.32 | 12.39 | 12.38 | 12.51 | 12.34 |
| 802.11a | 5220 | 44 | **12.33** | 12.26 | 12.29 | 12.29 | 12.22 | 12.26 | 12.42 | 12.21 |
| 802.11a | 5240 | 48* | 12.20 | 12.18 | 12.22 | 12.19 | 12.08 | 12.12 | 12.19 | 12.03 |
| 802.11a | 5260 | 52* | **13.08** | 13.15 | 13.18 | 13.20 | 13.18 | 13.10 | 13.29 | 13.06 |
| 802.11a | 5280 | 56 | 13.06 | 13.09 | 13.14 | 13.11 | 13.08 | 13.07 | 13.08 | 12.87 |
| 802.11a | 5300 | 60 | **12.93** | 12.99 | 13.05 | 13.00 | 12.98 | 13.03 | 13.02 | 12.79 |
| 802.11a | 5320 | 64* | 12.90 | 12.92 | 13.00 | 13.04 | 12.81 | 12.88 | 12.96 | 12.74 |
| 802.11a | 5500 | 100 | **13.18** | 13.21 | 13.16 | 13.16 | 13.15 | 13.18 | 13.22 | 13.03 |
| 802.11a | 5520 | 104* | 13.08 | 13.14 | 13.13 | 13.06 | 13.09 | 13.04 | 13.14 | 12.88 |
| 802.11a | 5540 | 108 | 13.08 | 13.01 | 13.06 | 13.05 | 13.08 | 13.11 | 13.07 | 12.88 |
| 802.11a | 5560 | 112 | 12.94 | 13.07 | 13.00 | 13.15 | 12.92 | 12.98 | 13.00 | 12.84 |
| 802.11a | 5580 | 116* | 12.87 | 13.09 | 12.95 | 13.09 | 12.85 | 13.15 | 13.04 | 12.71 |
| 802.11a | 5600 | 120 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5620 | 124 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5640 | 128 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11a | 5660 | 132 | 12.70 | 12.81 | 12.67 | 12.71 | 12.72 | 12.81 | 12.69 | 12.44 |
| 802.11a | 5680 | 136* | 12.56 | 12.49 | 12.58 | 12.55 | 12.57 | 12.71 | 12.66 | 12.42 |
| 802.11a | 5700 | 140 | 12.50 | 12.55 | 12.47 | 12.51 | 12.59 | 12.61 | 12.53 | 12.25 |
| 802.11a | 5745 | 149* | **12.51** | 12.53 | 12.40 | 12.59 | 12.50 | 12.51 | 12.59 | 12.44 |
| 802.11a | 5765 | 153 | 12.46 | 12.54 | 12.50 | 12.55 | 12.52 | 12.47 | 12.55 | 12.38 |
| 802.11a | 5785 | 157* | 12.32 | 12.40 | 12.46 | 12.37 | 12.38 | 12.31 | 12.55 | 12.30 |
| 802.11a | 5805 | 161* | 12.32 | 12.34 | 12.38 | 12.37 | 12.36 | 12.39 | 12.43 | 12.15 |
| 802.11a | 5825 | 165 | 12.26 | 12.18 | 12.26 | 12.22 | 12.26 | 12.16 | 12.37 | 12.08 |

Per FCC KDB Publication 443999 and RSS-210 A9.2(3), transmission on channels which overlap the 5600-5650 MHz is prohibited as a client. This device does not transmit any beacons or initiate any transmissions in 5.3 and 5.5 GHz Band.

(*) – indicates default channels per KDB Publication 248227 D01v01r02. When the adjacent channels are higher in power then the default channels, these “required channels” are considered for SAR testing instead of the default channels.

## Table 8-2
## IEEE 802.11n Average RF Power – 20 MHz Bandwidth

| Mode | Freq [MHz] | Channel | 20MHz BW 802.11n (5GHz) Conducted Power [dBm] Data Rate [Mbps] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6.5 | 13 | 20 | 26 | 39 | 52 | 58 | 65 |
| 802.11n | 5180 | 36 | 12.19 | 12.22 | 12.27 | 12.17 | 12.16 | 12.43 | 12.30 | 12.40 |
| 802.11n | 5200 | 40 | 12.27 | 12.21 | 12.37 | 12.21 | 12.33 | 12.27 | 12.26 | 12.13 |
| 802.11n | 5220 | 44 | 12.24 | 12.28 | 12.29 | 12.29 | 12.35 | 12.31 | 12.34 | 12.33 |
| 802.11n | 5240 | 48 | 12.36 | 12.25 | 12.29 | 12.17 | 12.26 | 12.35 | 12.40 | 12.32 |
| 802.11n | 5260 | 52 | 12.31 | 12.48 | 12.42 | 12.58 | 12.40 | 12.48 | 12.33 | 12.32 |
| 802.11n | 5280 | 56 | 12.27 | 12.31 | 12.32 | 12.31 | 12.33 | 12.35 | 12.34 | 12.27 |
| 802.11n | 5300 | 60 | 12.30 | 12.34 | 12.23 | 12.32 | 12.41 | 12.37 | 12.31 | 12.22 |
| 802.11n | 5320 | 64 | 12.18 | 12.18 | 12.16 | 12.30 | 12.27 | 12.22 | 12.45 | 12.42 |
| 802.11n | 5500 | 100 | 12.23 | 12.43 | 12.30 | 12.55 | 12.44 | 12.34 | 12.57 | 12.51 |
| 802.11n | 5520 | 104 | 12.38 | 12.32 | 12.35 | 12.33 | 12.42 | 12.30 | 12.42 | 12.27 |
| 802.11n | 5540 | 108 | 12.28 | 12.27 | 12.22 | 12.24 | 12.30 | 12.29 | 12.33 | 12.28 |
| 802.11n | 5560 | 112 | 12.36 | 12.35 | 12.26 | 12.30 | 12.34 | 12.36 | 12.35 | 12.31 |
| 802.11n | 5580 | 116 | 12.38 | 12.42 | 12.33 | 12.43 | 12.39 | 12.38 | 12.42 | 12.55 |
| 802.11n | 5600 | 120 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5620 | 124 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5640 | 128 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5660 | 132 | 12.13 | 12.15 | 12.21 | 12.19 | 12.15 | 12.24 | 12.23 | 12.08 |
| 802.11n | 5680 | 136 | 12.04 | 12.11 | 12.07 | 12.20 | 12.22 | 12.19 | 12.11 | 12.19 |
| 802.11n | 5700 | 140 | 12.20 | 12.15 | 12.02 | 12.04 | 12.12 | 12.08 | 12.13 | 12.09 |
| 802.11n | 5745 | 149 | 12.31 | 12.40 | 12.32 | 12.35 | 12.44 | 12.33 | 12.43 | 12.37 |
| 802.11n | 5765 | 153 | 12.24 | 12.20 | 12.14 | 12.21 | 12.28 | 12.30 | 12.36 | 12.37 |
| 802.11n | 5785 | 157 | 12.16 | 12.22 | 12.24 | 12.25 | 12.21 | 12.26 | 12.31 | 12.31 |
| 802.11n | 5805 | 161 | 12.13 | 12.25 | 12.34 | 12.28 | 12.27 | 12.15 | 12.25 | 12.22 |
| 802.11n | 5825 | 165 | 11.89 | 11.96 | 11.72 | 12.06 | 11.59 | 12.01 | 11.80 | 11.85 |

## Table 8-3
## IEEE 802.11n Average RF Power – 40 MHz Bandwidth

| Mode | Freq [MHz] | Channel | 40MHz BW 802.11n (5GHz) Conducted Power [dBm] Data Rate [Mbps] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 13.5 | 27 | 40.5 | 54 | 81 | 108 | 121.5 | 135 |
| 802.11n | 5190 | 38 | 12.64 | 12.55 | 12.57 | 12.59 | 12.55 | 12.46 | 12.57 | 12.63 |
| 802.11n | 5230 | 46 | 12.57 | 12.63 | 12.54 | 12.61 | 12.48 | 12.55 | 12.55 | 12.49 |
| 802.11n | 5270 | 54 | 13.03 | 12.90 | 12.96 | 12.95 | 12.94 | 13.01 | 13.04 | 12.97 |
| 802.11n | 5310 | 62 | 12.83 | 12.95 | 12.92 | 12.87 | 12.84 | 12.91 | 12.92 | 12.88 |
| 802.11n | 5510 | 102 | 12.67 | 12.60 | 12.43 | 12.42 | 12.46 | 12.55 | 12.50 | 12.48 |
| 802.11n | 5550 | 110 | 12.66 | 12.61 | 12.57 | 12.65 | 12.40 | 12.56 | 12.39 | 12.62 |
| 802.11n | 5590 | 118 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5630 | 126 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 802.11n | 5670 | 134 | 12.24 | 12.25 | 12.23 | 12.30 | 12.27 | 12.15 | 12.29 | 12.14 |
| 802.11n | 5755 | 151 | 12.18 | 12.16 | 12.04 | 11.90 | 11.80 | 11.67 | 11.62 | 11.44 |
| 802.11n | 5795 | 159 | 12.24 | 12.07 | 12.02 | 12.12 | 12.22 | 12.20 | 12.28 | 12.48 |

**Table 8-4**
**IEEE 802.11ac Average RF Power – 80 MHz Bandwidth**

| Mode | Freq | Channel | 80MHz BW 802.11ac (5GHz) Conducted Power [dBm] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate [Mbps] | | | | | | | | | |
| | [MHz] | | 29.3 | 58.5 | 87.8 | 117 | 175.5 | 234 | 263.3 | 292.2 | 351 | 390 |
| 802.11ac | 5210 | 42 | **12.78** | 12.81 | 12.73 | 12.63 | 12.72 | 12.59 | 12.72 | 12.70 | 12.57 | 12.59 |
| 802.11ac | 5290 | 58 | **12.12** | 12.22 | 12.22 | 12.28 | 12.33 | 12.29 | 12.26 | 12.29 | 12.27 | 12.33 |
| 802.11ac | 5530 | 106 | **12.22** | 12.31 | 12.36 | 12.21 | 12.14 | 12.28 | 12.27 | 12.19 | 12.14 | 12.17 |
| 802.11ac | 5775 | 155 | **12.33** | 12.37 | 12.48 | 12.55 | 12.43 | 12.30 | 12.29 | 12.31 | 12.33 | 12.23 |

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012/April 2013 FCC/TCB Meeting Notes:

- For 5 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11a were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11n 20 MHz and 40 MHz) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
- Full SAR tests for all IEEE 802.11ac configurations were not required because the average output power was not more than 0.25 dB higher than IEEE 802.11a mode. IEEE 802.11ac was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- Per the manufacturer FCC permissive change description for this device, the 5 GHz WLAN chipset remains the same as the original certified device. Therefore, conducted powers IEEE 802.11 a/b/g/n/ac remain the same as the original certification.
- The bolded data rate and channel above were tested for SAR.

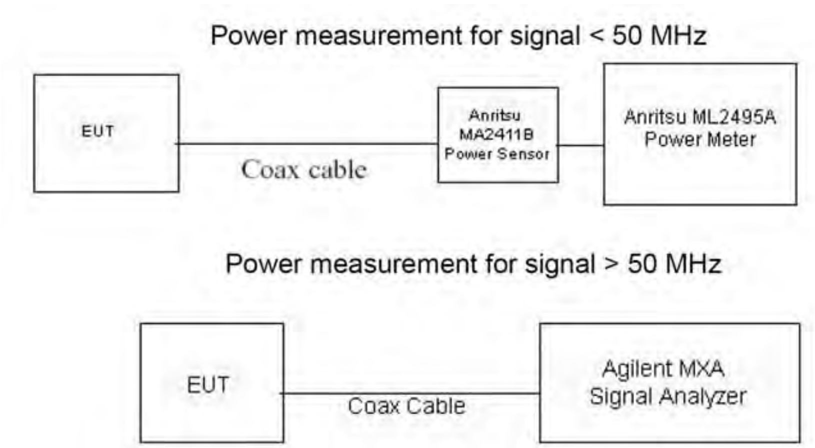



**Figure 8-1**
**Power Measurement Setup**

# 9 SYSTEM VERIFICATION

## 9.1 Tissue Verification

**Table 9-1**
**Measured Tissue Properties**

| Calibrated for Tests Performed on: | Tissue Type | Tissue Temp During Calibration (C°) | Measured Frequency (MHz) | Measured Conductivity, σ (S/m) | Measured Dielectric Constant, ε | TARGET Conductivity, σ (S/m) | TARGET Dielectric Constant, ε | % dev σ | % dev ε |
|---|---|---|---|---|---|---|---|---|---|
| 07/29/2013 | 5200H - 5800H | 22.6 | 5180 | 4.672 | 34.951 | 4.639 | 36.020 | 0.71% | -2.97% |
| | | | 5200 | 4.688 | 34.839 | 4.660 | 36.000 | 0.60% | -3.23% |
| | | | 5220 | 4.704 | 34.872 | 4.680 | 35.980 | 0.51% | -3.08% |
| | | | 5260 | 4.764 | 34.797 | 4.720 | 35.940 | 0.93% | -3.18% |
| | | | 5280 | 4.811 | 34.742 | 4.740 | 35.920 | 1.50% | -3.28% |
| | | | 5300 | 4.826 | 34.642 | 4.760 | 35.900 | 1.39% | -3.50% |
| | | | 5500 | 5.080 | 34.302 | 4.965 | 35.650 | 2.32% | -3.78% |
| | | | 5520 | 5.101 | 34.266 | 4.986 | 35.620 | 2.31% | -3.80% |
| | | | 5540 | 5.122 | 34.219 | 5.007 | 35.590 | 2.30% | -3.85% |
| | | | 5745 | 5.318 | 33.825 | 5.215 | 35.355 | 1.98% | -4.33% |
| | | | 5765 | 5.334 | 33.761 | 5.235 | 35.335 | 1.89% | -4.45% |
| | | | 5785 | 5.349 | 33.702 | 5.255 | 35.315 | 1.79% | -4.57% |
| | | | 5800 | 5.370 | 33.638 | 5.270 | 35.300 | 1.90% | -4.71% |
| 07/29/2013 | 5200B - 5800B | 22.5 | 5180 | 5.490 | 47.448 | 5.276 | 49.041 | 4.06% | -3.25% |
| | | | 5200 | 5.509 | 47.650 | 5.299 | 49.014 | 3.96% | -2.78% |
| | | | 5220 | 5.512 | 47.603 | 5.323 | 48.987 | 3.55% | -2.83% |
| | | | 5260 | 5.540 | 47.289 | 5.369 | 48.906 | 3.18% | -3.31% |
| | | | 5280 | 5.565 | 47.119 | 5.393 | 48.879 | 3.19% | -3.60% |
| | | | 5300 | 5.603 | 47.250 | 5.416 | 48.851 | 3.45% | -3.28% |
| | | | 5500 | 5.785 | 47.011 | 5.650 | 48.580 | 2.39% | -3.23% |
| | | | 5520 | 5.808 | 46.934 | 5.673 | 48.553 | 2.38% | -3.33% |
| | | | 5540 | 5.871 | 46.936 | 5.696 | 48.526 | 3.07% | -3.28% |
| | | | 5745 | 6.092 | 46.454 | 5.936 | 48.248 | 2.63% | -3.72% |
| | | | 5765 | 6.127 | 46.386 | 5.959 | 48.220 | 2.82% | -3.80% |
| | | | 5785 | 6.187 | 46.361 | 5.982 | 48.242 | 3.43% | -3.90% |
| | | | 5800 | 6.205 | 46.385 | 6.000 | 48.200 | 3.42% | -3.77% |
| 08/05/2013 | 5200B | 23.4 | 5200 | 5.512 | 46.801 | 5.299 | 49.014 | 4.02% | -4.52% |
| | | | 5220 | 5.486 | 47.059 | 5.323 | 48.987 | 3.06% | -3.94% |

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per IEEE 1528 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

## 9.2 Test System Verification

Prior to SAR assessment, the system is verified to ±10% of the SAR measurement on the reference dipole at the time of calibration by the calibration facility. Full system validation status and result summary can be found in Appendix E.

**Table 9-2**
**System Verification Results**

| System Verification TARGET & MEASURED | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAR System # | Tissue Frequency (MHz) | Tissue Type | Date: | Amb. Temp (°C) | Liquid Temp (°C) | Input Power (W) | Dipole SN | Probe SN | Measured $SAR_{1g}$ (W/kg) | 1 W Target $SAR_{1g}$ (W/kg) | 1 W Normalized $SAR_{1g}$ (W/kg) | $Deviation_{1g}$ (%) |
| A | 5200 | HEAD | 07/29/2013 | 24.3 | 22.7 | 0.100 | 1057 | 3589 | 7.710 | 75.900 | 77.100 | 1.58% |
| A | 5300 | HEAD | 07/29/2013 | 24.3 | 22.7 | 0.100 | 1057 | 3589 | 8.280 | 76.900 | 82.800 | 7.67% |
| A | 5500 | HEAD | 07/29/2013 | 24.4 | 22.8 | 0.100 | 1057 | 3589 | 7.650 | 80.100 | 76.500 | -4.49% |
| A | 5800 | HEAD | 07/29/2013 | 24.4 | 22.9 | 0.100 | 1057 | 3589 | 8.020 | 76.100 | 80.200 | 5.39% |
| A | 5200 | BODY | 07/29/2013 | 23.7 | 22.6 | 0.100 | 1057 | 3589 | 7.560 | 75.500 | 75.600 | 0.13% |
| A | 5300 | BODY | 07/29/2013 | 23.7 | 22.6 | 0.100 | 1057 | 3589 | 7.830 | 75.300 | 78.300 | 3.98% |
| A | 5500 | BODY | 07/29/2013 | 23.7 | 22.6 | 0.100 | 1057 | 3589 | 8.230 | 80.800 | 82.300 | 1.86% |
| A | 5800 | BODY | 07/29/2013 | 23.8 | 22.7 | 0.100 | 1057 | 3589 | 7.370 | 75.100 | 73.700 | -1.86% |
| A | 5200 | BODY | 08/05/2013 | 23.8 | 22.7 | 0.100 | 1057 | 3589 | 7.670 | 75.500 | 76.700 | 1.59% |

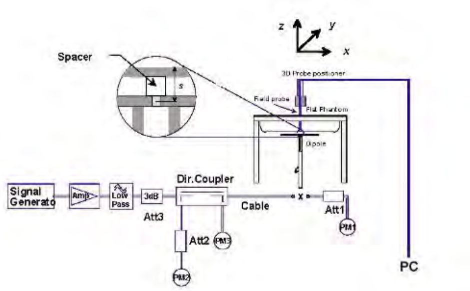



**Figure 9-1**
**System Verification Setup Diagram**

**Figure 9-2**
**System Verification Setup Photo**

# 10 SAR DATA SUMMARY

## 10.1 Standalone Head SAR Data

**Table 10-1**
**DTS Head SAR**

MEASUREMENT RESULTS

| FREQUENCY | | Mode | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Side | Test Position | Back Cover Type | Device Serial Number | Data Rate (Mbps) | SAR (1g) | Scaling Factor | Scaled SAR (1g) | Plot # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | | | (W/kg) | | (W/kg) | |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | 0.03 | Right | Cheek | Standard | FK-193-A | 6 | 0.026 | 1.256 | 0.033 | |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | 0.00 | Right | Tilt | Standard | FK-193-A | 6 | 0.008 | 1.256 | 0.010 | |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | 0.09 | Left | Cheek | Standard | FK-193-A | 6 | 0.192 | 1.256 | **0.241** | A1 |
| 5775 | 155 | IEEE 802.11ac | OFDM | 13.0 | 12.33 | 0.03 | Left | Cheek | Standard | FK-193-A | 29.3 | 0.036 | 1.167 | 0.042 | |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | 0.03 | Left | Tilt | Standard | FK-193-A | 6 | 0.018 | 1.256 | 0.023 | |

| ANSI / IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population | Head<br>1.6 W/kg (mW/g)<br>averaged over 1 gram |
|---|---|

**Table 10-2**
**NII Head SAR**

MEASUREMENT RESULTS

| FREQUENCY | | Mode | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Side | Test Position | Back Cover Type | Device Serial Number | Data Rate (Mbps) | SAR (1g) | Scaling Factor | Scaled SAR (1g) | Plot # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | Ch. | | | | | | | | | | | (W/kg) | | (W/kg) | |
| 5180 | 36 | IEEE 802.11a | OFDM | 13.5 | 12.57 | 0.15 | Right | Cheek | Standard | FK-193-A | 6 | 0.058 | 1.239 | 0.072 | |
| 5180 | 36 | IEEE 802.11a | OFDM | 13.5 | 12.57 | -0.11 | Right | Tilt | Standard | FK-193-A | 6 | 0.024 | 1.239 | 0.030 | |
| 5180 | 36 | IEEE 802.11a | OFDM | 13.5 | 12.57 | 0.10 | Left | Cheek | Standard | FK-193-A | 6 | 0.327 | 1.239 | **0.405** | |
| 5210 | 42 | IEEE 802.11ac | OFDM | 13.0 | 12.78 | -0.05 | Left | Cheek | Standard | FK-193-A | 29.3 | 0.142 | 1.052 | 0.149 | |
| 5180 | 36 | IEEE 802.11a | OFDM | 13.5 | 12.57 | 0.03 | Left | Tilt | Standard | FK-193-A | 6 | 0.059 | 1.239 | 0.073 | |
| 5260 | 52 | IEEE 802.11a | OFDM | 13.5 | 13.08 | 0.06 | Right | Cheek | Standard | FK-193-A | 6 | 0.059 | 1.102 | 0.065 | |
| 5260 | 52 | IEEE 802.11a | OFDM | 13.5 | 13.08 | 0.02 | Right | Tilt | Standard | FK-193-A | 6 | 0.026 | 1.102 | 0.029 | |
| 5260 | 52 | IEEE 802.11a | OFDM | 13.5 | 13.08 | 0.15 | Left | Cheek | Standard | FK-193-A | 6 | 0.364 | 1.102 | 0.401 | A2 |
| 5290 | 58 | IEEE 802.11ac | OFDM | 13.0 | 12.12 | -0.04 | Left | Cheek | Standard | FK-193-A | 29.3 | 0.140 | 1.225 | 0.172 | |
| 5260 | 52 | IEEE 802.11a | OFDM | 13.5 | 13.08 | -0.01 | Left | Cheek | Wireless Charging Cover | FK-193-A | 6 | 0.196 | 1.102 | 0.216 | |
| 5260 | 52 | IEEE 802.11a | OFDM | 13.5 | 13.08 | 0.18 | Left | Tilt | Standard | FK-193-A | 6 | 0.058 | 1.102 | 0.064 | |
| 5500 | 100 | IEEE 802.11a | OFDM | 13.5 | 13.18 | 0.11 | Right | Cheek | Standard | FK-193-A | 6 | 0.031 | 1.076 | 0.033 | |
| 5500 | 100 | IEEE 802.11a | OFDM | 13.5 | 13.18 | 0.02 | Right | Tilt | Standard | FK-193-A | 6 | 0.023 | 1.076 | 0.025 | |
| 5500 | 100 | IEEE 802.11a | OFDM | 13.5 | 13.18 | 0.08 | Left | Cheek | Standard | FK-193-A | 6 | 0.146 | 1.076 | 0.157 | |
| 5530 | 106 | IEEE 802.11ac | OFDM | 13.0 | 12.22 | 0.07 | Left | Cheek | Standard | FK-193-A | 29.3 | 0.071 | 1.197 | 0.085 | |
| 5500 | 100 | IEEE 802.11a | OFDM | 13.5 | 13.18 | 0.04 | Left | Tilt | Standard | FK-193-A | 6 | 0.018 | 1.076 | 0.019 | |

| ANSI / IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population | Head<br>1.6 W/kg (mW/g)<br>averaged over 1 gram |
|---|---|

## 10.2 Standalone Body-Worn SAR Data

**Table 10-3**
**DTS Body-Worn SAR**

| MEASUREMENT RESULTS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FREQUENCY MHz | FREQUENCY Ch. | Mode | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Spacing | Back Cover Type | Device Serial Number | Data Rate (Mbps) | Side | SAR (1g) (W/kg) | Scaling Factor | Scaled SAR (1g) (W/kg) | Plot # |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | 0.03 | 10 mm | Standard | FK-193-A | 6 | back | 0.095 | 1.256 | **0.119** | A3 |
| 5775 | 155 | IEEE 802.11ac | OFDM | 13.0 | 12.33 | -0.20 | 10 mm | Standard | FK-193-A | 29.3 | back | 0.097 | 1.167 | 0.113 | |
| ANSI / IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population | | | | | | | Body<br>1.6 W/kg (mW/g)<br>averaged over 1 gram | | | | | | | | |

**Table 10-4**
**NII Body-Worn SAR**

| MEASUREMENT RESULTS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FREQUENCY MHz | FREQUENCY Ch. | Mode | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Spacing | Battery Type | Device Serial Number | Data Rate (Mbps) | Side | SAR (1g) (W/kg) | Scaling Factor | Scaled SAR (1g) (W/kg) | Plot # |
| 5180 | 36 | IEEE 802.11a | OFDM | 13.5 | 12.57 | -0.05 | 10 mm | Standard | FK-193-A | 6 | back | 0.602 | 1.239 | 0.746 | |
| 5220 | 44 | IEEE 802.11a | OFDM | 13.5 | 12.33 | 0.05 | 10 mm | Standard | FK-193-A | 6 | back | 0.626 | 1.309 | **0.819** | A5 |
| 5210 | 42 | IEEE 802.11ac | OFDM | 13.0 | 12.78 | 0.01 | 10 mm | Standard | FK-193-A | 29.3 | back | 0.601 | 1.052 | 0.632 | |
| 5220 | 44 | IEEE 802.11a | OFDM | 13.5 | 12.33 | -0.03 | 10 mm | Wireless Charging Cover | FK-193-A | 6 | back | 0.268 | 1.309 | 0.351 | |
| 5260 | 52 | IEEE 802.11a | OFDM | 13.5 | 13.08 | 0.03 | 10 mm | Standard | FK-193-A | 6 | back | 0.607 | 1.102 | 0.669 | |
| 5300 | 60 | IEEE 802.11a | OFDM | 13.5 | 12.93 | -0.01 | 10 mm | Standard | FK-193-A | 6 | back | 0.525 | 1.140 | 0.599 | |
| 5290 | 58 | IEEE 802.11ac | OFDM | 13.0 | 12.12 | 0.06 | 10 mm | Standard | FK-193-A | 29.3 | back | 0.598 | 1.225 | 0.733 | |
| 5500 | 100 | IEEE 802.11a | OFDM | 13.5 | 13.18 | 0.08 | 10 mm | Standard | FK-193-A | 6 | back | 0.301 | 1.076 | 0.324 | |
| 5530 | 106 | IEEE 802.11ac | OFDM | 13.0 | 12.22 | -0.07 | 10 mm | Standard | FK-193-A | 29.3 | back | 0.264 | 1.197 | 0.316 | |
| ANSI / IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population | | | | | | | Body<br>1.6 W/kg (mW/g)<br>averaged over 1 gram | | | | | | | | |

## 10.3 Standalone Wireless Router SAR Data

**Table 10-5**
**WLAN Hotspot SAR**

| MEASUREMENT RESULTS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FREQUENCY MHz | FREQUENCY Ch. | Mode | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Spacing | Back Cover Type | Device Serial Number | Data Rate (Mbps) | Side | SAR (1g) (W/kg) | Scaling Factor | Scaled SAR (1g) (W/kg) | Plot # |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | 0.03 | 10 mm | Standard | FK-193-A | 6 | back | 0.095 | 1.256 | 0.119 | |
| 5775 | 155 | IEEE 802.11ac | OFDM | 13.0 | 12.33 | -0.20 | 10 mm | Standard | FK-193-A | 29.3 | back | 0.097 | 1.167 | 0.113 | |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | 0.03 | 10 mm | Wireless Charging Cover | FK-193-A | 6 | back | 0.180 | 1.256 | **0.226** | A4 |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | 0.00 | 10 mm | Standard | FK-193-A | 6 | front | 0.000 | 1.256 | 0.000 | |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | -0.02 | 10 mm | Standard | FK-193-A | 6 | top | 0.008 | 1.256 | 0.010 | |
| 5745 | 149 | IEEE 802.11a | OFDM | 13.5 | 12.51 | -0.01 | 10 mm | Standard | FK-193-A | 6 | right | 0.060 | 1.256 | 0.075 | |
| ANSI / IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population | | | | | | | Body<br>1.6 W/kg (mW/g)<br>averaged over 1 gram | | | | | | | | |

## 10.4 SAR Test Notes

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC/OET Bulletin 65, Supplement C [June 2001] and FCC KDB Publication 447498 D01v05.
2. Batteries are fully charged at the beginning of the SAR measurements. A standard battery with NFC Antenna was used for all SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05.
6. Device was tested using a fixed spacing for body-worn accessory testing. A separation distance of 10 mm was considered because the manufacturer has determined that there will be body-worn accessories available in the marketplace for users to support this separation distance.
7. Per FCC KDB Publication 648474 D04v01, SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was ≤ 1.2 W/kg, no additional SAR evaluations using a headset cable were required.
8. Per FCC KDB 865664 D01v01r01, since the measured SAR results for all band/modes were not greater than 0.8 W/kg. Repeated SAR measurements are not required. Please see Section 12.
9. During SAR Testing for the Wireless Router conditions per FCC KDB Publication 941225 D06v01, the actual Portable Hotspot operation (with actual simultaneous transmission of a transmitter with WIFI) was not activated (See Section 5.7 for more details).
10. Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012 FCC/TCB Meeting Notes for 5 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11a. Other IEEE 802.11 modes (including 802.11n 20 MHz and 40 MHz bandwidths) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11a mode.
11. Per April 2013 TCB Workshop notes, full SAR tests for all IEEE 802.11ac configurations were not required because the average output power was not more than 0.25 dB higher than IEEE 802.11a mode. IEEE 802.11ac was evaluated for the highest IEEE 802.11a position in each 5 GHz band and exposure condition.
12. WIFI transmission was verified using an uncalibrated spectrum analyzer.
13. When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other default channels was not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
14. Per the FCC change document for this device, the 5 GHz WLAN chipset remains the same as the original certified device. Therefore, conducted powers IEEE 802.11 a/b/g/n/ac remain the same as the original certification.

# 11 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

## 11.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v05 are applicable to handsets with built-in unlicensed transmitters such as 802.11a/b/g/n/ac and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

## 11.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v05 IV.C.1.iii, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤1.6 W/kg.

## 11.3 Head SAR Simultaneous Transmission Analysis

**Table 11-1**
**Simultaneous Transmission Scenario with 5 GHz WLAN (Held to Ear)**

| Simult Tx | Configuration | GSM 850 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) | Simult Tx | Configuration | UMTS 850 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|
| Head SAR | Right Cheek | 0.282 | 0.072 | 0.354 | Head SAR | Right Cheek | 0.319 | 0.072 | 0.391 |
| | Right Tilt | 0.191 | 0.030 | 0.221 | | Right Tilt | 0.254 | 0.030 | 0.284 |
| | Left Cheek | 0.304 | 0.405 | 0.709 | | Left Cheek | 0.375 | 0.405 | 0.780 |
| | Left Tilt | 0.176 | 0.073 | 0.249 | | Left Tilt | 0.242 | 0.073 | 0.315 |
| Simult Tx | Configuration | GSM 1900 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) | Simult Tx | Configuration | UMTS 1900 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
| Head SAR | Right Cheek | 0.141 | 0.072 | 0.213 | Head SAR | Right Cheek | 0.253 | 0.072 | 0.325 |
| | Right Tilt | 0.119 | 0.030 | 0.149 | | Right Tilt | 0.193 | 0.030 | 0.223 |
| | Left Cheek | 0.295 | 0.405 | 0.700 | | Left Cheek | 0.469 | 0.405 | 0.874 |
| | Left Tilt | 0.101 | 0.073 | 0.174 | | Left Tilt | 0.155 | 0.073 | 0.228 |
| Simult Tx | Configuration | LTE Band 17 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) | Simult Tx | Configuration | LTE Band 5 (Cell) SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
| Head SAR | Right Cheek | 0.118 | 0.072 | 0.190 | Head SAR | Right Cheek | 0.241 | 0.072 | 0.313 |
| | Right Tilt | 0.077 | 0.030 | 0.107 | | Right Tilt | 0.149 | 0.030 | 0.179 |
| | Left Cheek | 0.130 | 0.405 | 0.535 | | Left Cheek | 0.344 | 0.405 | 0.749 |
| | Left Tilt | 0.074 | 0.073 | 0.147 | | Left Tilt | 0.150 | 0.073 | 0.223 |
| Simult Tx | Configuration | LTE Band 4 (AWS) SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) | Simult Tx | Configuration | LTE Band 2 (PCS) SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
| Head SAR | Right Cheek | 0.315 | 0.072 | 0.387 | Head SAR | Right Cheek | 0.274 | 0.072 | 0.346 |
| | Right Tilt | 0.323 | 0.030 | 0.353 | | Right Tilt | 0.230 | 0.030 | 0.260 |
| | Left Cheek | 0.605 | 0.405 | **1.010** | | Left Cheek | 0.585 | 0.405 | 0.990 |
| | Left Tilt | 0.244 | 0.073 | 0.317 | | Left Tilt | 0.202 | 0.073 | 0.275 |

Note: The worst case 5 GHz WLAN reported SAR for each head configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Direct capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN.

## 11.4 Body-Worn Simultaneous Transmission Analysis

**Table 11-2**
**Simultaneous Transmission Scenario with 5 GHz WLAN (Body-Worn at 10 mm)**

| Configuration | Mode | 2G/3G/4G SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
|---|---|---|---|---|
| Back Side | GSM 850 | 0.656 | 0.819 | 1.475 |
| Back Side | UMTS 850 | 0.555 | 0.819 | 1.374 |
| Back Side | GSM 1900 | 0.433 | 0.819 | 1.252 |
| Back Side | UMTS 1900 | 0.523 | 0.819 | 1.342 |
| Back Side | LTE Band 17 | 0.301 | 0.819 | 1.120 |
| Back Side | LTE Band 5 (Cell) | 0.629 | 0.819 | 1.448 |
| Back Side | LTE Band 4 (AWS) | 0.765 | 0.819 | **1.584** |
| Back Side | LTE Band 2 (PCS) | 0.755 | 0.819 | 1.574 |

Note: The worst case 5 GHz WLAN reported SAR for each head configuration was used for SAR summation, regardless of whether the WLAN channel has WIFI Direct capability. Therefore, the summations above represent the absolute worst cases for simultaneous transmission with 5 GHz WLAN.

## 11.5 Wireless Router SAR Simultaneous Transmission Analysis

Per FCC KDB Publication 941225 D06v01, the devices edges with antennas more than 2.5 cm from edge are not required to be evaluated for SAR ("-").

**Table 11-3**
**Simultaneous Transmission Scenario (5.8 GHz Wireless Router at 1.0 cm)**

| Simult Tx | Configuration | GPRS 850 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) | Simult Tx | Configuration | UMTS 850 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|
| Body SAR | Back | 0.782 | 0.226 | **1.008** | Body SAR | Back | 0.555 | 0.226 | 0.781 |
| | Front | 0.513 | 0.000 | 0.513 | | Front | 0.473 | 0.000 | 0.473 |
| | Top | - | 0.010 | 0.010 | | Top | - | 0.010 | 0.010 |
| | Bottom | 0.106 | - | 0.106 | | Bottom | 0.069 | - | 0.069 |
| | Right | 0.513 | 0.075 | 0.588 | | Right | 0.416 | 0.075 | 0.491 |
| | Left | 0.665 | - | 0.665 | | Left | 0.468 | - | 0.468 |

| Simult Tx | Configuration | GPRS 1900 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) | Simult Tx | Configuration | UMTS 1900 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|
| Body SAR | Back | 0.528 | 0.226 | 0.754 | Body SAR | Back | 0.523 | 0.226 | 0.749 |
| | Front | 0.482 | 0.000 | 0.482 | | Front | 0.680 | 0.000 | 0.680 |
| | Top | - | 0.010 | 0.010 | | Top | - | 0.010 | 0.010 |
| | Bottom | 0.396 | - | 0.396 | | Bottom | 0.416 | - | 0.416 |
| | Right | 0.045 | 0.075 | 0.120 | | Right | 0.046 | 0.075 | 0.121 |
| | Left | 0.284 | - | 0.284 | | Left | 0.310 | - | 0.310 |
| Simult Tx | Configuration | LTE Band 17 SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) | Simult Tx | Configuration | LTE Band 5 (Cell) SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
| Body SAR | Back | 0.301 | 0.226 | 0.527 | Body SAR | Back | 0.629 | 0.226 | 0.855 |
| | Front | 0.233 | 0.000 | 0.233 | | Front | 0.530 | 0.000 | 0.530 |
| | Top | - | 0.010 | 0.010 | | Top | - | 0.010 | 0.010 |
| | Bottom | 0.051 | - | 0.051 | | Bottom | 0.090 | - | 0.090 |
| | Right | 0.128 | 0.075 | 0.203 | | Right | 0.506 | 0.075 | 0.581 |
| | Left | 0.140 | - | 0.140 | | Left | 0.487 | - | 0.487 |
| Simult Tx | Configuration | LTE Band 4 (AWS) SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) | Simult Tx | Configuration | LTE Band 2 (PCS) SAR (W/kg) | 5 GHz WLAN SAR (W/kg) | Σ SAR (W/kg) |
| Body SAR | Back | 0.765 | 0.226 | 0.991 | Body SAR | Back | 0.755 | 0.226 | 0.981 |
| | Front | 0.792 | 0.000 | 0.792 | | Front | 0.675 | 0.000 | 0.675 |
| | Top | - | 0.010 | 0.010 | | Top | - | 0.010 | 0.010 |
| | Bottom | 0.493 | - | 0.493 | | Bottom | 0.552 | - | 0.552 |
| | Right | 0.053 | 0.075 | 0.128 | | Right | 0.079 | 0.075 | 0.154 |
| | Left | 0.354 | - | 0.354 | | Left | 0.394 | - | 0.394 |

## 11.6 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v05.

# 12 SAR MEASUREMENT VARIABILITY

## 12.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r01, SAR measurement variability is assessed when measured 1g SAR is > 0.80 W/kg. Since all measured 1g SAR values were < 0.8 W/kg for this device, SAR measurement variability was not assessed.

## 12.2 Measurement Uncertainty

The measured SAR was <1.5 W/kg for all frequency bands. Therefore, per KDB Publication 865664 D01v01, the extended measurement uncertainty analysis per IEEE 1528-2003 was not required.

# 13 EQUIPMENT LIST

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | E8257D | (250kHz-20GHz) Signal Generator | 4/16/2013 | Annual | 4/16/2014 | MY45470194 |
| Agilent | 8753E | (30kHz-6GHz) Network Analyzer | 4/16/2013 | Annual | 4/16/2014 | JP38020182 |
| Agilent | 8594A | (9kHz-2.9GHz) Spectrum Analyzer | N/A | N/A | N/A | 3051A00187 |
| Agilent | 8648D | (9kHz-4GHz) Signal Generator | 4/17/2013 | Annual | 4/17/2014 | 3629U00687 |
| Agilent | 85070C | Dielectric Probe Kit | 2/14/2013 | Annual | 2/14/2014 | MY44300633 |
| Agilent | N9020N | MXA Signal Analyzer | 10/9/2012 | Annual | 10/9/2013 | US46470561 |
| Agilent | 85047A | S-Parameter Test Set | N/A | N/A | N/A | 2904A00579 |
| Amplifier Research | 5S1G4 | 5W, 800MHz-4.2GHz | CBT | N/A | CBT | 21910 |
| Anritsu | ML2495A | Power Meter | 10/11/2012 | Annual | 10/11/2013 | 1039008 |
| Anritsu | ML2496A | Power Meter | 11/28/2012 | Annual | 11/28/2013 | 1138001 |
| Anritsu | MA2481A | Power Sensor | 2/14/2013 | Annual | 2/14/2014 | 5821 |
| Anritsu | MA2411B | Pulse Sensor | 9/19/2012 | Annual | 9/19/2013 | 1027293 |
| Anritsu | MA2481D | Universal Sensor | 12/17/2012 | Annual | 12/17/2013 | 1204419 |
| Anritsu | MA2481D | Universal Sensor | 12/17/2012 | Annual | 12/17/2013 | 1204343 |
| COMTECH | AR85729-5/5759B | Solid State Amplifier | CBT | N/A | CBT | M3W1A00-1002 |
| COMTech | AR85729-5 | Solid State Amplifier | CBT | N/A | CBT | M1S5A00-009 |
| Control Company | 4353 | Long Stem Thermometer | 9/25/2012 | Biennial | 9/25/2014 | 122541143 |
| Control Company | 36934-158 | Wall-Mounted Thermometer | 1/4/2012 | Biennial | 1/4/2014 | 122014488 |
| Gigatronics | 80701A | (0.05-18GHz) Power Sensor | 10/10/2012 | Annual | 10/10/2013 | 1833460 |
| Gigatronics | 8651A | Universal Power Meter | 10/10/2012 | Annual | 10/10/2013 | 8650319 |
| MCL | BW-N6W5+ | 6dB Attenuator | CBT | N/A | CBT | 1139 |
| MiniCircuits | VLF-6000+ | Low Pass Filter | CBT | N/A | CBT | N/A |
| MiniCircuits | VLF-6000+ | Low Pass Filter | CBT | N/A | CBT | N/A |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | BW-N20W5 | Power Attenuator | CBT | N/A | CBT | 1226 |
| Narda | 4014C-6 | 4 - 8 GHz SMA 6 dB Directional Coupler | CBT | N/A | CBT | N/A |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Narda | BW-S3W2 | Attenuator (3dB) | CBT | N/A | CBT | 120 |
| Pasternack | PE2208-6 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Pasternack | PE2209-10 | Bidirectional Coupler | CBT | N/A | CBT | N/A |
| Rohde & Schwarz | NRV-Z32 | Peak Power Sensor | 10/12/2012 | Biennial | 10/12/2014 | 836019/013 |
| Rohde & Schwarz | SME06 | Signal Generator | 10/11/2012 | Annual | 10/11/2013 | 832026 |
| Rohde & Schwarz | SMIQ03B | Signal Generator | 4/17/2013 | Annual | 4/17/2014 | DE27259 |
| Seekonk | NC-100 | Torque Wrench (8" lb) | 11/29/2011 | Triennial | 11/29/2014 | 21053 |
| SPEAG | D5GHzV2 | 5 GHz SAR Dipole | 1/11/2013 | Annual | 1/11/2014 | 1057 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 1/17/2013 | Annual | 1/17/2014 | 1272 |
| SPEAG | EX3DV4 | SAR Probe | 1/17/2013 | Annual | 1/17/2014 | 3589 |
| Tektronix | RSA6114A | Real Time Spectrum Analyzer | 4/17/2013 | Annual | 4/17/2014 | B010177 |

Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.

# 14 MEASUREMENT UNCERTAINTIES

| a | b | c | d | e= f(d,k) | f | g | h = c x f/e | i = c x g/e | k |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | **IEEE 1528 Sec.** | **Tol. (± %)** | **Prob. Dist.** | **Div.** | **$c_i$ 1gm** | **$c_i$ 10 gms** | **1gm $u_i$ (± %)** | **10gms $u_i$ (± %)** | **$v_i$** |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E.2.1 | 6.55 | N | 1 | 1.0 | 1.0 | 6.6 | 6.6 | ∞ |
| Axial Isotropy | E.2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E.2.2 | 1.3 | N | 1 | 1.0 | 1.0 | 1.3 | 1.3 | ∞ |
| Boundary Effect | E.2.3 | 0.4 | N | 1 | 1.0 | 1.0 | 0.4 | 0.4 | ∞ |
| Linearity | E.2.4 | 0.3 | N | 1 | 1.0 | 1.0 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E.2.5 | 5.1 | N | 1 | 1.0 | 1.0 | 5.1 | 5.1 | ∞ |
| Readout Electronics | E.2.6 | 1.0 | N | 1 | 1.0 | 1.0 | 1.0 | 1.0 | ∞ |
| Response Time | E.2.7 | 0.8 | R | 1.73 | 1.0 | 1.0 | 0.5 | 0.5 | ∞ |
| Integration Time | E.2.8 | 2.6 | R | 1.73 | 1.0 | 1.0 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions | E.6.1 | 3.0 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E.6.2 | 0.4 | R | 1.73 | 1.0 | 1.0 | 0.2 | 0.2 | ∞ |
| Probe Positioning w/ respect to Phantom | E.6.3 | 2.9 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E.5 | 1.0 | R | 1.73 | 1.0 | 1.0 | 0.6 | 0.6 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E.4.2 | 6.0 | N | 1 | 1.0 | 1.0 | 6.0 | 6.0 | 287 |
| Device Holder Uncertainty | E.4.1 | 3.32 | R | 1.73 | 1.0 | 1.0 | 1.9 | 1.9 | ∞ |
| Output Power Variation - SAR drift measurement | 6.6.2 | 5.0 | R | 1.73 | 1.0 | 1.0 | 2.9 | 2.9 | ∞ |
| **Phantom & Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E.3.1 | 4.0 | R | 1.73 | 1.0 | 1.0 | 2.3 | 2.3 | ∞ |
| Liquid Conductivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity - measurement uncertainty | E.3.3 | 3.8 | N | 1 | 0.64 | 0.43 | 2.4 | 1.6 | 6 |
| Liquid Permittivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity - measurement uncertainty | E.3.3 | 4.5 | N | 1 | 0.60 | 0.49 | 2.7 | 2.2 | 6 |
| **Combined Standard Uncertainty (k=1)** | | | RSS | | | | 12.4 | 12.0 | 299 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | k=2 | | | | 24.7 | 24.0 | |

The above measurement uncertainties are according to IEEE Std. 1528-2003

# 15 CONCLUSION

## 15.1 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Industry Canada, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

# 16 REFERENCES


[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, Aug. 1996.

[2] ANSI/IEEE C95.1-2005, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, 2006.

[3] ANSI/IEEE C95.1-1992, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, Sept. 1992.

[4] ANSI/IEEE C95.3-2002, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave, New York: IEEE, December 2002.

[5] Federal Communications Commission, OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, June 2001.

[6] IEEE Standards Coordinating Committee 34 – IEEE Std. 1528-2003, Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices.

[7] NCRP, National Council on Radiation Protection and Measurements, Biological Effects and Exposure Criteria for RadioFrequency Electromagnetic Fields, NCRP Report No. 86, 1986. Reprinted Feb. 1995.

[8] T. Schmid, O. Egger, N. Kuster, Automated E-field scanning system for dosimetric assessments, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.

[9] K. Pokovic, T. Schmid, N. Kuster, Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies, ICECOM97, Oct. 1997, pp. -124.

[10] K. Pokovic, T. Schmid, and N. Kuster, E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, Croatia, June 23-25, 1996, pp. 172-175.

[11] Schmid & Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.

[12] V. Hombach, K. Meier, M. Burkhardt, E. Kuhn, N. Kuster, The Dependence of EM Energy Absorption upon Human Modeling at 900 MHz, IEEE Transaction on Microwave Theory and Techniques, vol. 44 no. 10, Oct. 1996, pp. 1865-1873.

[13] N. Kuster and Q. Balzano, Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

[14] G. Hartsgrove, A. Kraszewski, A. Surowiec, Simulated Biological Materials for Electromagnetic Radiation Absorption Studies, University of Ottawa, Bioelectromagnetics, Canada: 1987, pp. 29-36.

[15] Q. Balzano, O. Garay, T. Manning Jr., Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.

[16] W. Gander, Computermathematick, Birkhaeuser, Basel, 1992.

[17] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second edition, Cambridge University Press, 1992.

[18] Federal Communications Commission, OET Bulletin 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields. Supplement C, Dec. 1997.

[19] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.

[20] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10kHz-300GHz, Jan. 1995.

[21] Prof. Dr. Niels Kuster, ETH, Eidgenössische Technische Hoschschule Zürich, Dosimetric Evaluation of the Cellular Phone.

[22] IEC 62209-1, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz), Feb. 2005.

[23] Industry Canada RSS-102 Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) Issue 4, March 2010.

[24] Health Canada Safety Code 6 Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range from 3 kHz – 300 GHz, 2009

[25] FCC Public Notice DA-02-1438. Office of Engineering and Technology Announces a Transition Period for the Phantom Requirements of Supplement C to OET Bulletin 65, June 19, 2002

[26] FCC SAR Test Procedures for 2G-3G Devices, Mobile Hotspot and UMPC Devices KDB Publications 941225, D01-D07

[27] SAR Measurement procedures for IEEE 802.11a/b/g KDB Publication 248227 D01v01r02

[28] FCC SAR Considerations for Handsets with Multiple Transmitters and Antennas, KDB Publications 648474 D02-D04

[29] FCC SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers, FCC KDB Publication 616217 D04

[30] FCC SAR Measurement and Reporting Requirements for 100MHz – 6 GHz, KDB Publications 865664 D01-D02

[31] FCC General RF Exposure Guidance and SAR Procedures for Dongles, KDB Publication 447498, D01-D02

[32] Anexo à Resolução No. 533, de 10 de Septembro de 2009.

[33] IEC 62209-2, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz), Mar. 2010.

# APPENDIX A: SAR TEST DATA

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSGHI337; Type: Portable Handset; Serial: FK-193-A**

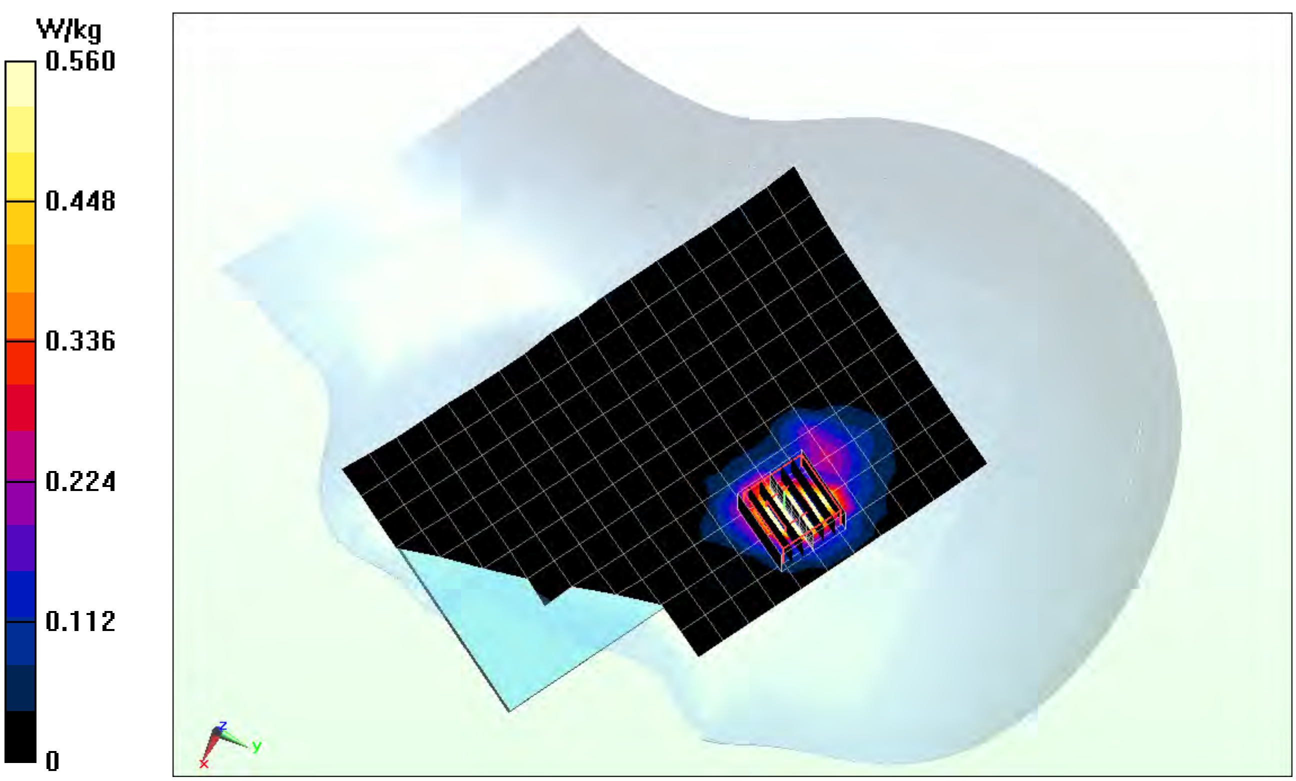
Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5745 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head; Medium parameters used:
f = 5745 MHz; $\sigma$ = 5.318 S/m; $\varepsilon_r$ = 33.825; $\rho$ = 1000 kg/$m^3$
Phantom section: Left Section

Test Date: 07-29-2013; Ambient Temp: 24.4°C; Tissue Temp: 22.9°C

Probe: EX3DV4 - SN3589; ConvF(3.85, 3.85, 3.85); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11a, 5.8 GHz Left Head, Cheek,**
**Ch 149, 6 Mbps, Standard Cover**

**Area Scan (12x18x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 6.174 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 0.964 W/kg
**SAR(1 g) = 0.192 W/kg**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSGHI337; Type: Portable Handset; Serial: FK-193-A**

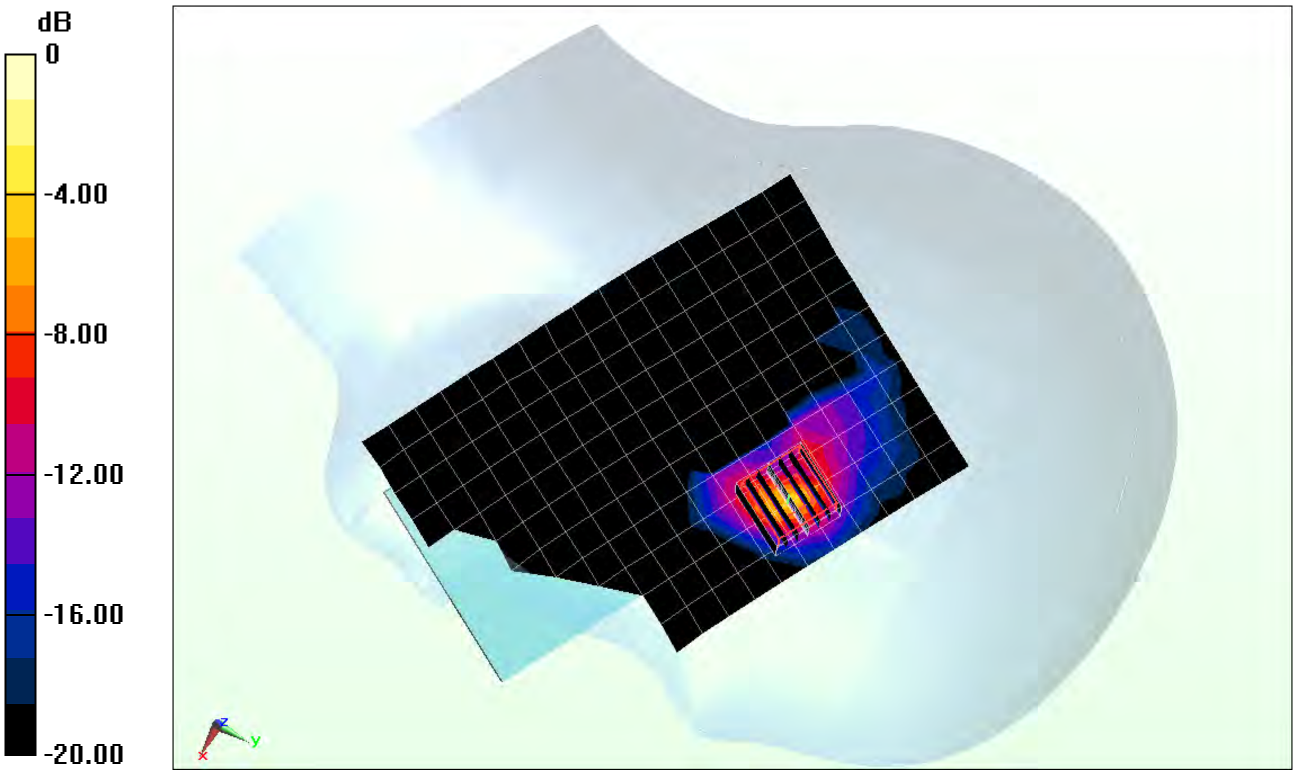
Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5260 MHz;Duty Cycle: 1:1
Medium: 5 GHz Head; Medium parameters used:
f = 5260 MHz; $\sigma$ = 4.764 S/m; $\varepsilon_r$ = 34.797; $\rho$ = 1000 kg/$m^3$
Phantom section: Left Section

Test Date: 07-29-2013; Ambient Temp: 24.3°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(4.27, 4.27, 4.27); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11a, 5.3 GHz Left Head, Cheek,**
**Ch 52, 6 Mbps, Standard Cover**

**Area Scan (12x17x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 9.710 V/m; Power Drift = 0.15 dB
Peak SAR (extrapolated) = 1.58 W/kg
**SAR(1 g) = 0.364 W/kg**




0 dB = 1.50 W/kg = 1.76 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSGHI337; Type: Portable Handset; Serial: FK-193-A**

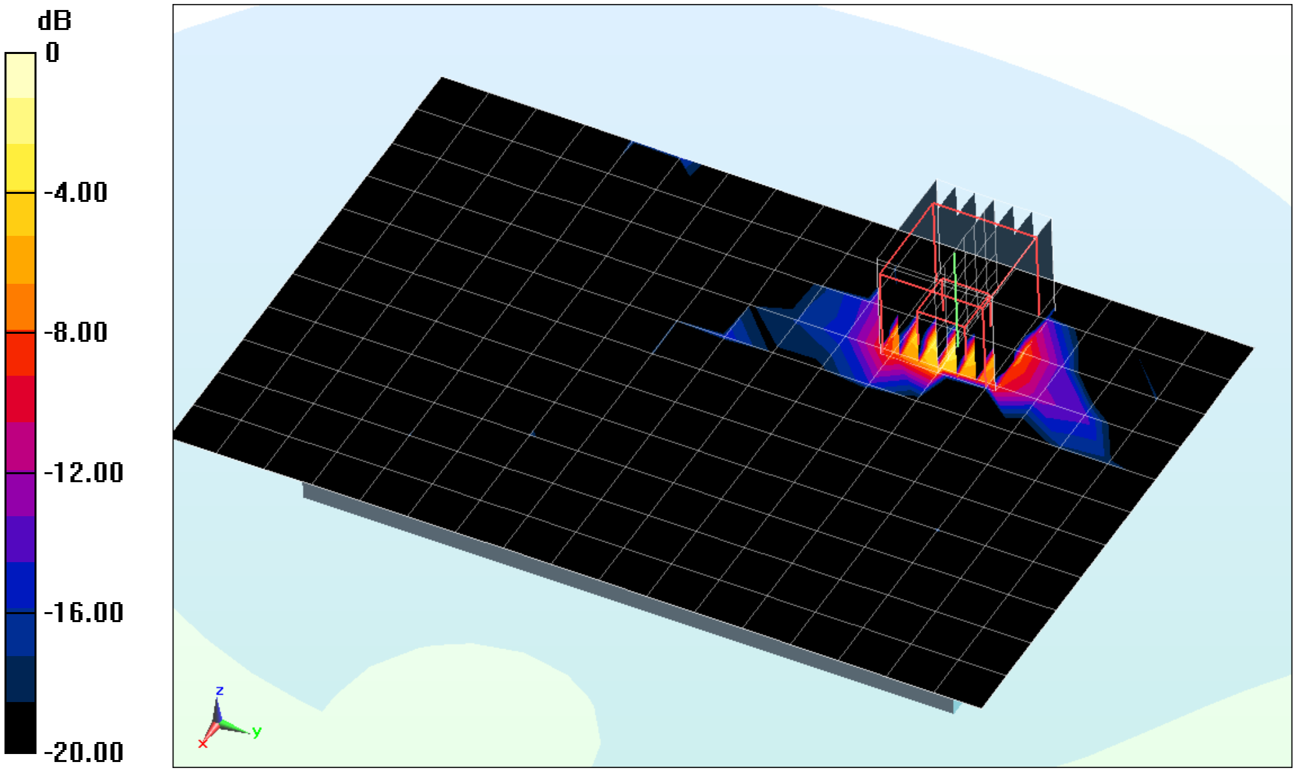
Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5745 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body; Medium parameters used:
f = 5745 MHz; $\sigma$ = 6.092 S/m; $\varepsilon_r$ = 46.454; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(3.66, 3.66, 3.66); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11a, 5.8 GHz, Body SAR,**
**Ch 149, 6 Mbps, Back Side, Standard Cover**

**Area Scan (12x18x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 4.141 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 0.605 W/kg
**SAR(1 g) = 0.095 W/kg**




0 dB = 0.281 W/kg = -5.51 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSGHI337; Type: Portable Handset; Serial: FK-193-A**

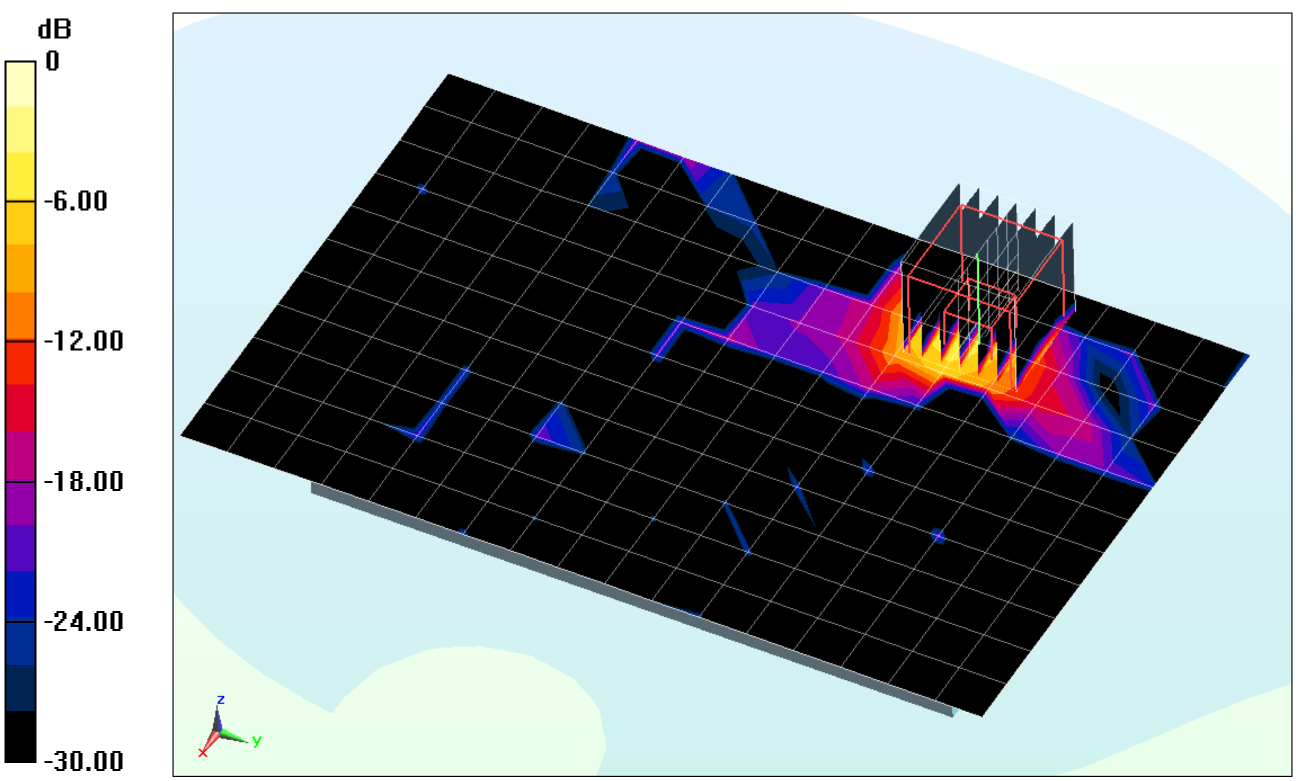
Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5745 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body; Medium parameters used:
f = 5745 MHz; $\sigma$ = 6.092 S/m; $\varepsilon_r$ = 46.454; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(3.66, 3.66, 3.66); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11a, 5.8 GHz, Body SAR,**
**Ch 149, 6 Mbps, Back Side, Wireless Charging Cover**

**Area Scan (12x18x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 5.616 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 0.723 W/kg
**SAR(1 g) = 0.180 W/kg**




0 dB = 0.488 W/kg = -3.12 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSGHI337; Type: Portable Handset; Serial: FK-193-A**

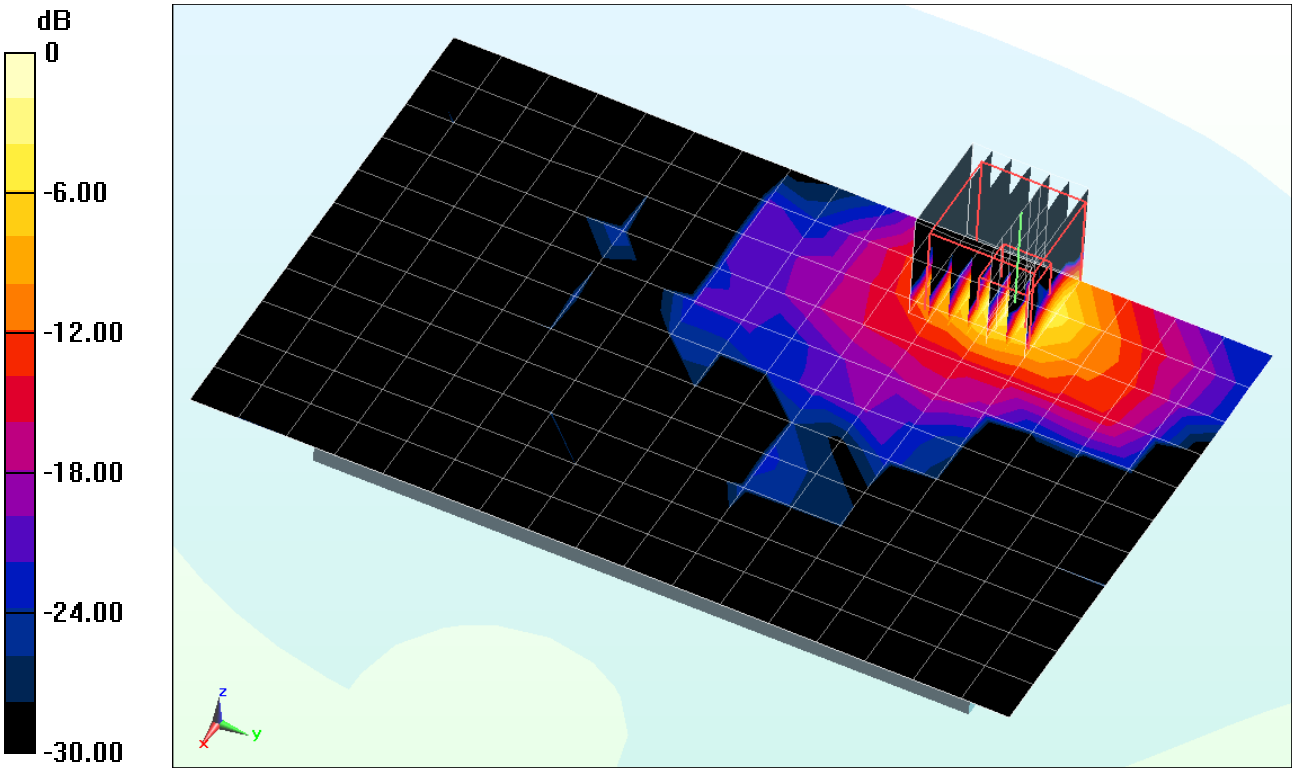
Communication System: IEEE 802.11a 5.2-5.8 GHz Band; Frequency: 5220 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body; Medium parameters used:
f = 5220 MHz; $\sigma$ = 5.486 S/m; $\varepsilon_r$ = 47.059; $\rho$ = 1000 kg/$m^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 08-05-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(3.99, 3.99, 3.99); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

**Mode: IEEE 802.11a, 5.2 GHz, Body SAR,**
**Ch 44, 6 Mbps, Back Side, Standard Cover**

**Area Scan (12x18x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Reference Value = 11.167 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 2.92 W/kg
**SAR(1 g) = 0.626 W/kg**




0 dB = 1.51 W/kg = 1.79 dBW/kg

# APPENDIX B: SYSTEM VERIFICATION

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5200 MHz; Type: D5GHzV2; Serial: 1057**

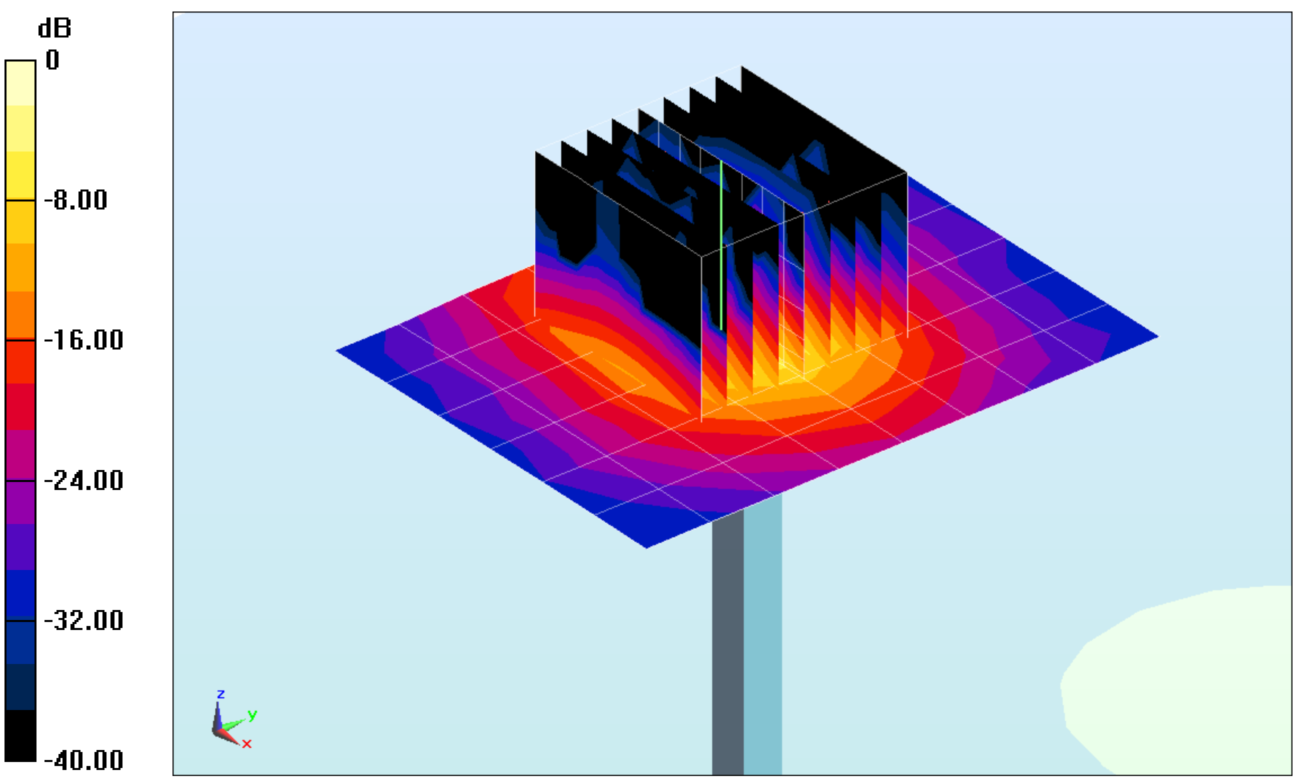
Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head; Medium parameters used:
f = 5200 MHz; $\sigma$ = 4.688 S/m; $\varepsilon_r$ = 34.839; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 24.3°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(4.48, 4.48, 4.48); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

## 5200MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 29.9 W/kg
**SAR(1 g) = 7.71 W/kg**
Deviation = 1.58%




0 dB = 19.4 W/kg = 12.88 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5300 MHz; Type: D5GHzV2; Serial: 1057**

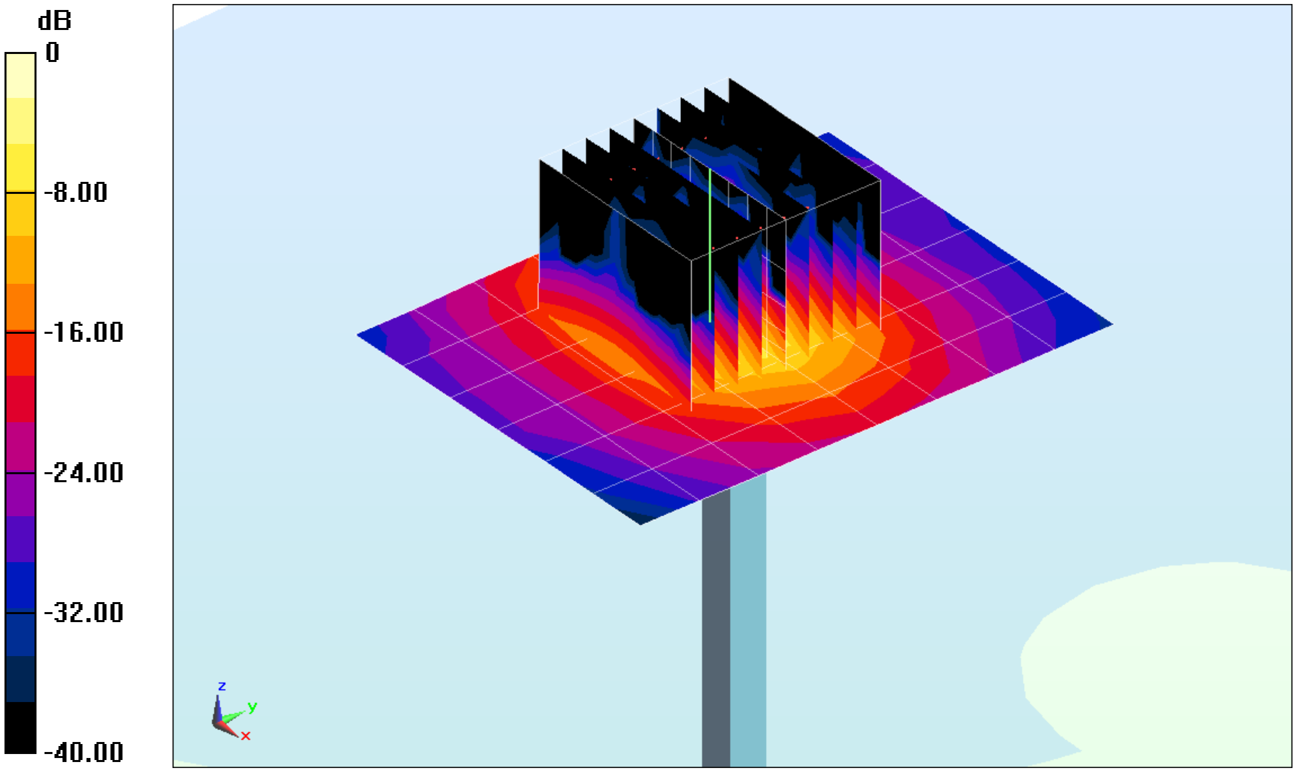
Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head; Medium parameters used:
f = 5300 MHz; $\sigma$ = 4.826 S/m; $\varepsilon_r$ = 34.642; $\rho$ = 1000 kg/$m^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 24.3°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(4.27, 4.27, 4.27); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

## 5300MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 33.8 W/kg
**SAR(1 g) = 8.28 W/kg**
Deviation = 7.67%




0 dB = 20.7 W/kg = 13.16 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5500 MHz; Type: D5GHzV2; Serial: 1057**

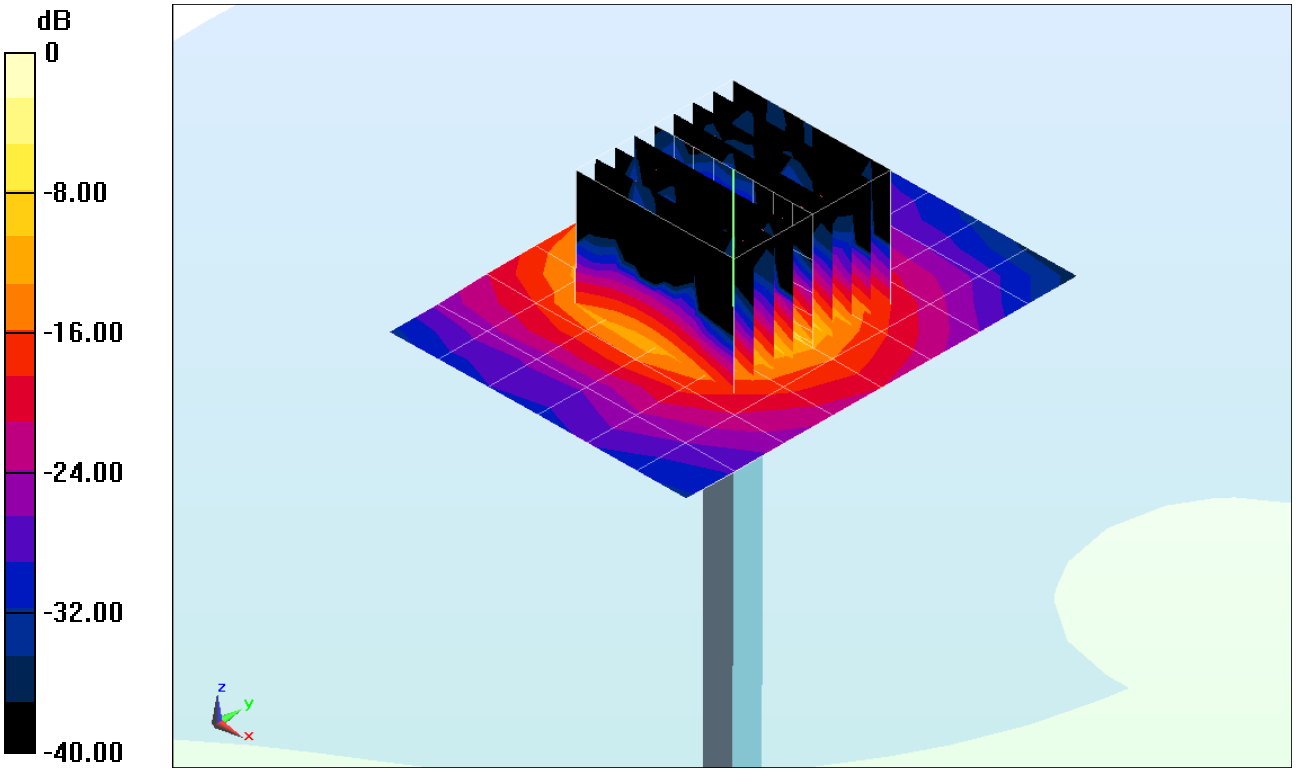
Communication System: CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head; Medium parameters used:
f = 5500 MHz; $\sigma$ = 5.08 S/m; $\varepsilon_r$ = 34.302; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 24.4°C; Tissue Temp: 22.8°C

Probe: EX3DV4 - SN3589; ConvF(4.14, 4.14, 4.14); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

## 5500MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 35.4 W/kg
**SAR(1 g) = 7.65 W/kg**
Deviation = -4.49%




0 dB = 19.9 W/kg = 12.99 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5800 MHz; Type: D5GHzV2; Serial: 1057**

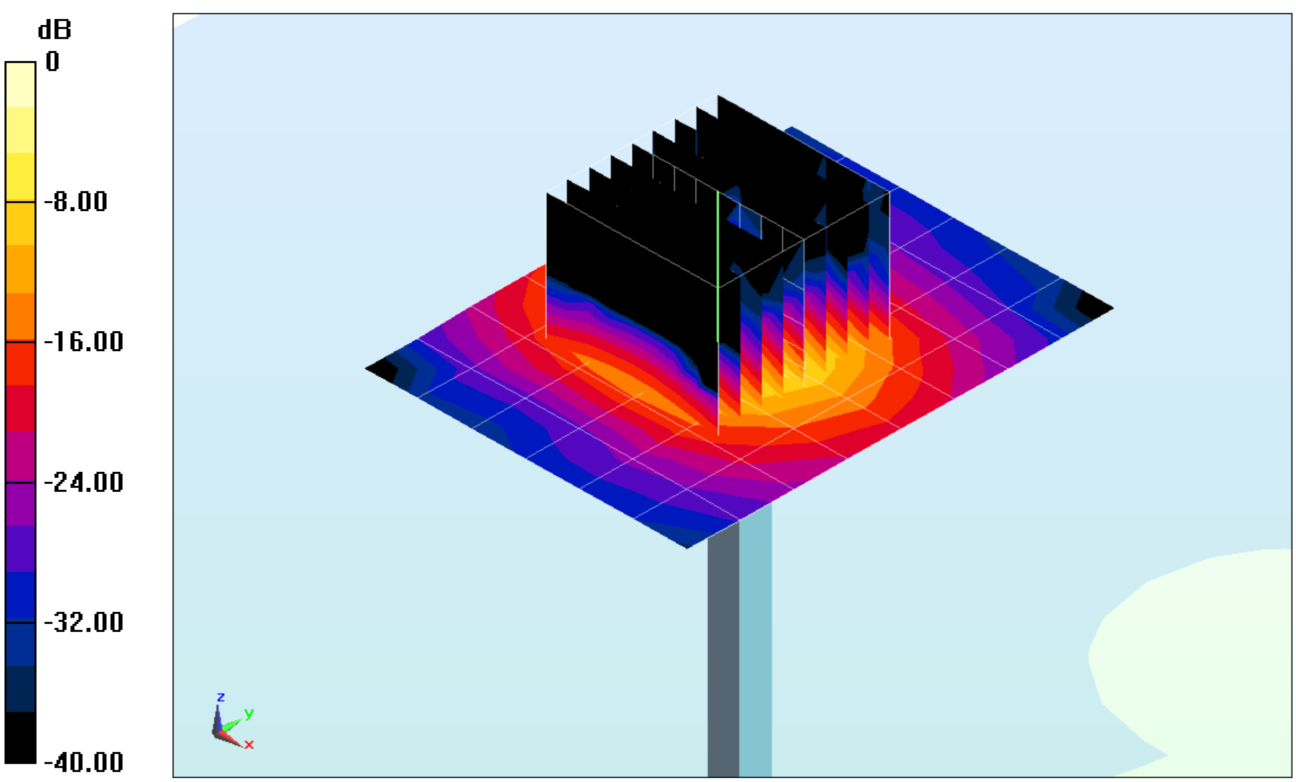
Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium: 5 GHz Head; Medium parameters used:
f = 5800 MHz; $\sigma$ = 5.37 S/m; $\varepsilon_r$ = 33.638; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 24.4°C; Tissue Temp: 22.9°C

Probe: EX3DV4 - SN3589; ConvF(3.85, 3.85, 3.85); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

## 5800MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 37.4 W/kg
**SAR(1 g) = 8.02 W/kg**
Deviation = 5.39%




0 dB = 20.7 W/kg = 13.16 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5200 MHz; Type: D5GHzV2; Serial: 1057**

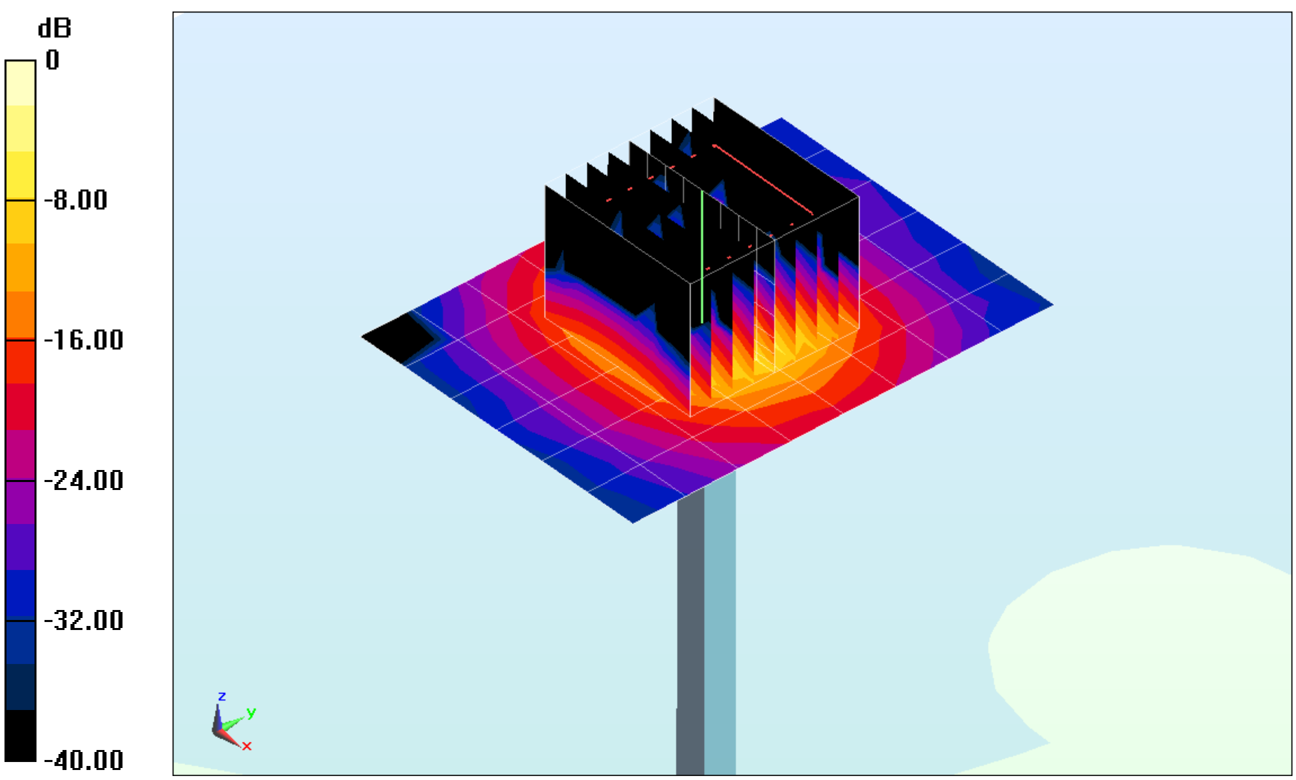
Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body; Medium parameters used:
f = 5200 MHz; $\sigma$ = 5.512 S/m; $\varepsilon_r$ = 46.801; $\rho$ = 1000 kg/$m^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 08-05-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(3.99, 3.99, 3.99); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

## 5200MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 30.1 W/kg
**SAR(1 g) = 7.67 W/kg**
Deviation = 1.59%




0 dB = 18.5 W/kg = 12.67 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5300 MHz; Type: D5GHzV2; Serial: 1057**

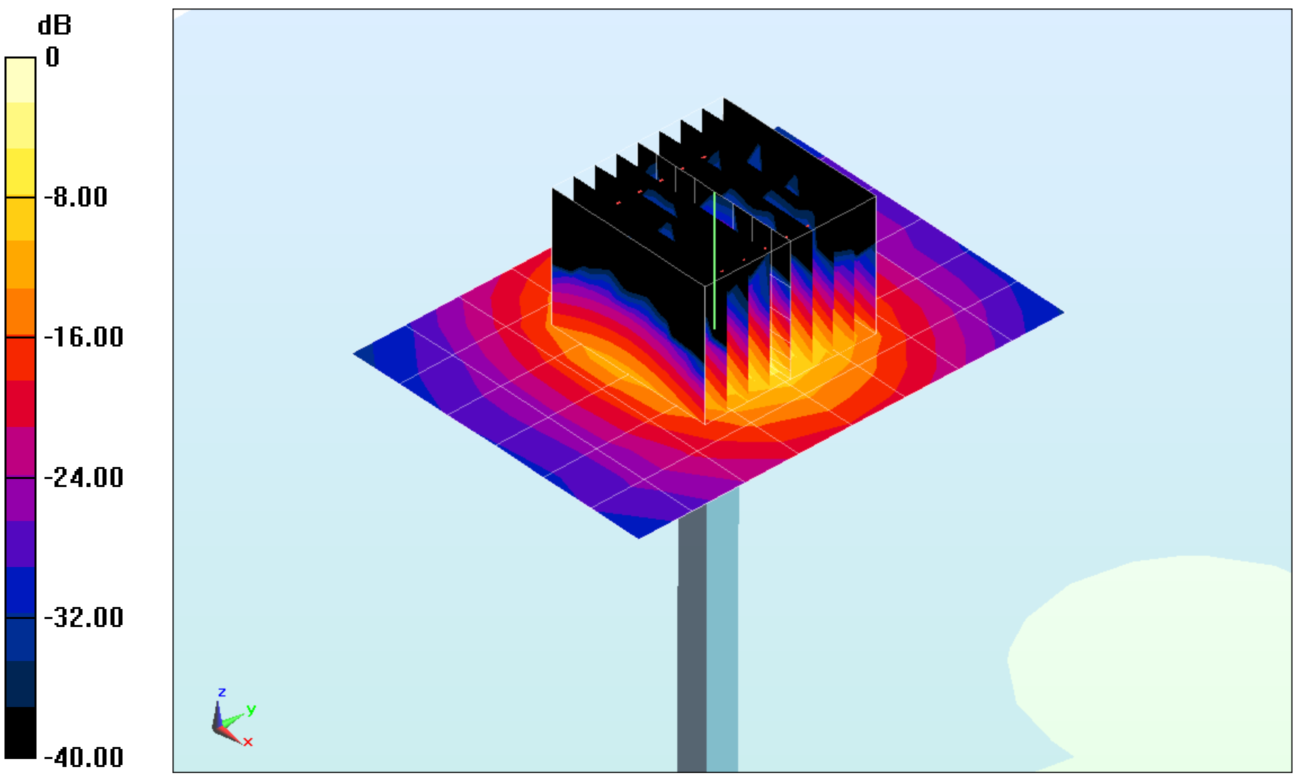
Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body; Medium parameters used:
f = 5300 MHz; $\sigma$ = 5.603 S/m; $\varepsilon_r$ = 47.25; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 23.7°C; Tissue Temp: 22.6°C

Probe: EX3DV4 - SN3589; ConvF(3.81, 3.81, 3.81); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

## 5300MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 29.1 W/kg
**SAR(1 g) = 7.83 W/kg**
Deviation = 3.98%




0 dB = 19.4 W/kg = 12.88 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5500 MHz; Type: D5GHzV2; Serial: 1057**

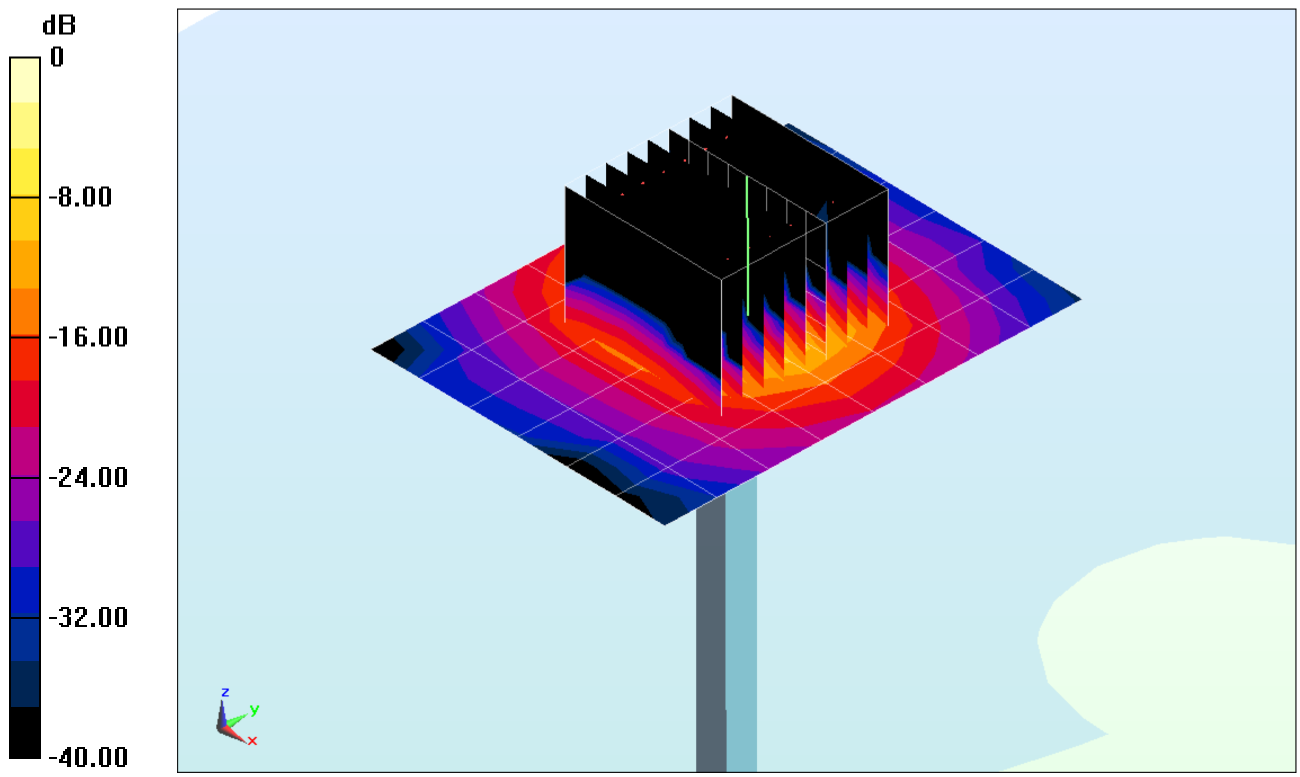
Communication System: CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body; Medium parameters used:
f = 5500 MHz; $\sigma$ = 5.785 S/m; $\varepsilon_r$ = 47.011; $\rho$ = 1000 kg/$m^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 23.7°C; Tissue Temp: 22.6°C

Probe: EX3DV4 - SN3589; ConvF(3.52, 3.52, 3.52); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

## 5500MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 40.0 W/kg
**SAR(1 g) = 8.23 W/kg**
Deviation = 1.86%




0 dB = 20.5 W/kg = 13.12 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 5800 MHz; Type: D5GHzV2; Serial: 1057**

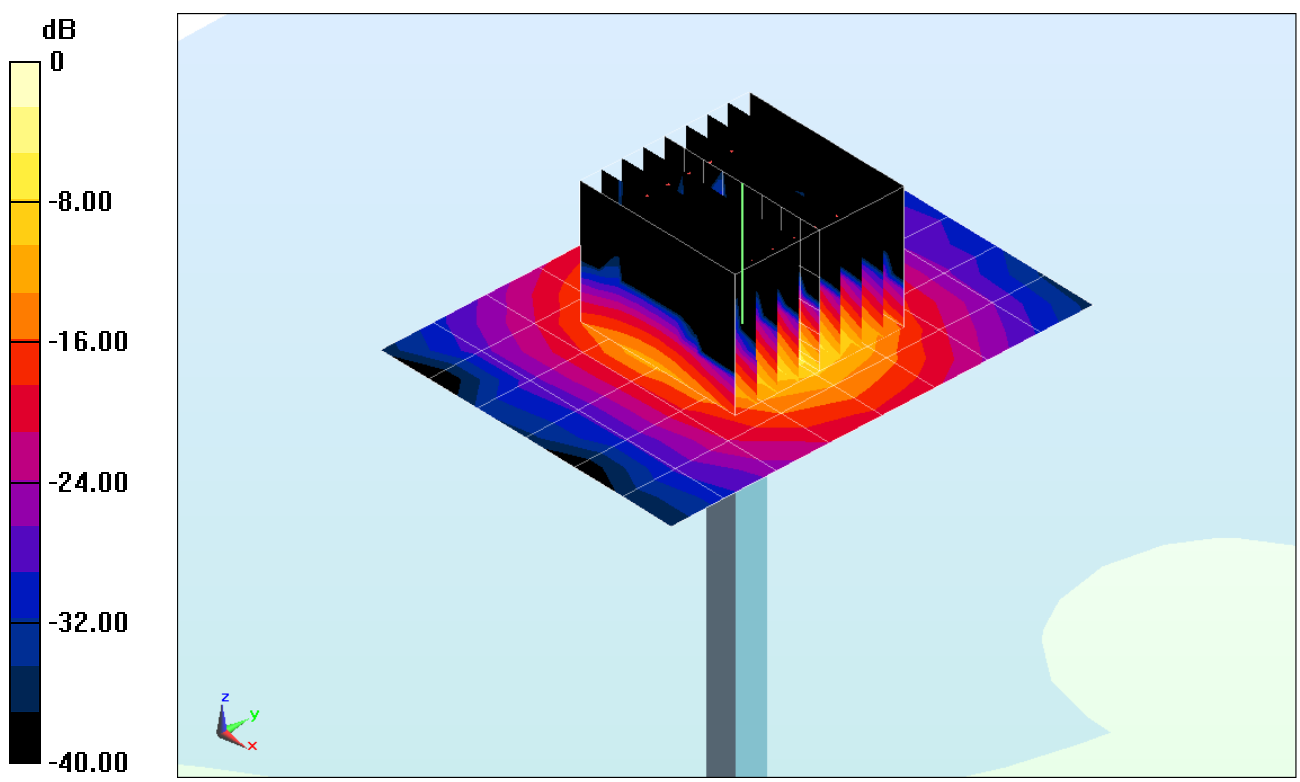
Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium: 5 GHz Body; Medium parameters used:
f = 5800 MHz; $\sigma$ = 6.205 S/m; $\varepsilon_r$ = 46.385; $\rho$ = 1000 kg/$m^3$
Phantom section: Flat Section; Space: 1.0 cm

Test Date: 07-29-2013; Ambient Temp: 23.8°C; Tissue Temp: 22.7°C

Probe: EX3DV4 - SN3589; ConvF(3.66, 3.66, 3.66); Calibrated: 1/17/2013;
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1272; Calibrated: 1/17/2013
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, Version 4.7 (80);SEMCAD X Version 14.6.10 (7164)

## 5800MHz System Verification

**Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm
**Zoom Scan (9x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm; Graded Ratio: 1.4
Input Power = 20.0 dBm (100 mW)
Peak SAR (extrapolated) = 31.5 W/kg
**SAR(1 g) = 7.37 W/kg**
Deviation = -1.86%




0 dB = 18.6 W/kg = 12.70 dBW/kg

# APPENDIX C: PROBE CALIBRATION

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
**Zeughausstrasse 43, 8004 Zurich, Switzerland**

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

**Accreditation No.: SCS 108**

**Client** **PC Test**

**Certificate No: D5GHzV2-1057_Jan13**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D5GHzV2 - SN: 1057 |
| Calibration procedure(s) | QA CAL-22.v2<br>Calibration procedure for dipole validation kits between 3-6 GHz |
| Calibration date: | January 11, 2013 |

✓ KOK 1/28/13

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Power sensor HP 8481A | US37292783 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 27-Mar-12 (No. 217-01530) | Apr-13 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 27-Mar-12 (No. 217-01533) | Apr-13 |
| Reference Probe EX3DV4 | SN: 3503 | 28-Dec-12 (No. EX3-3503_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 27-Jun-12 (No. DAE4-601_Jun12) | Jun-13 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Israe El-Naouq | Laboratory Technician | Israe El-Naouq |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 11, 2013

## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| ConvF | sensitivity in TSL / NORM x,y,z |
| N/A | not applicable or not measured |

## Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
b) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

## Additional Documentation:

c) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.5 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy = 4.0 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| **Frequency** | 5200 MHz ± 1 MHz<br>5300 MHz ± 1 MHz<br>5500 MHz ± 1 MHz<br>5600 MHz ± 1 MHz<br>5800 MHz ± 1 MHz | |

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 36.0 | 4.66 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.6 ± 6 % | 4.50 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5200 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.66 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **75.9 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.17 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.4 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.9 | 4.76 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.5 ± 6 % | 4.60 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5300 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.76 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **76.9 W / kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.22 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.9 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.6 | 4.96 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.2 ± 6 % | 4.79 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5500 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.09 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **80.1 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.28 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **22.5 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.5 | 5.07 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.1 ± 6 % | 4.88 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5600 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.12 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **80.4 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.30 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **22.7 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.3 | 5.27 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 33.8 ± 6 % | 5.09 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 5800 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.69 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **76.1 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.17 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.4 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 49.0 | 5.30 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 47.0 ± 6 % | 5.42 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5200 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.61 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **75.5 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.13 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.1 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.9 | 5.42 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.8 ± 6 % | 5.55 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5300 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.59 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **75.3 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.13 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.1 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.6 | 5.65 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.5 ± 6 % | 5.81 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5500 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.14 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **80.8 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.26 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **22.4 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.5 | 5.77 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.3 ± 6 % | 5.94 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5600 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.10 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **80.3 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.25 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **22.3 W/kg ± 19.5 % (k=2)** |

## Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.2 | 6.00 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 46.0 ± 6 % | 6.21 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL at 5800 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.57 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **75.1 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.09 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **20.7 W/kg ± 19.5 % (k=2)** |

## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 50.5 Ω - 9.8 jΩ |
| Return Loss | - 20.3 dB |

### Antenna Parameters with Head TSL at 5300 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 48.5 Ω - 4.5 jΩ |
| Return Loss | - 26.4 dB |

### Antenna Parameters with Head TSL at 5500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 50.6 Ω - 5.8 jΩ |
| Return Loss | - 24.8 dB |

### Antenna Parameters with Head TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 53.9 Ω - 3.8 jΩ |
| Return Loss | - 25.6 dB |

### Antenna Parameters with Head TSL at 5800 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 52.5 Ω - 4.4 jΩ |
| Return Loss | - 26.1 dB |

### Antenna Parameters with Body TSL at 5200 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 49.3 Ω - 7.9 jΩ |
| Return Loss | - 22.0 dB |

### Antenna Parameters with Body TSL at 5300 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 48.7 Ω - 3.2 jΩ |
| Return Loss | - 29.2 dB |

### Antenna Parameters with Body TSL at 5500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 51.2 Ω - 4.8 jΩ |
| Return Loss | - 26.2 dB |

### Antenna Parameters with Body TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 53.6 Ω - 2.1 jΩ |
| Return Loss | - 27.9 dB |

## Antenna Parameters with Body TSL at 5800 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 53.3 Ω - 2.9 jΩ |
| Return Loss | - 27.4 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.202 ns |

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

## Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | November 27, 2006 |

## DASY5 Validation Report for Head TSL

Date: 11.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1057**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; $\sigma$ = 4.5 S/m; $\varepsilon_r$ = 34.6; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5300 MHz; $\sigma$ = 4.6 S/m; $\varepsilon_r$ = 34.5; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5500 MHz; $\sigma$ = 4.79 S/m; $\varepsilon_r$ = 34.2; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5600 MHz; $\sigma$ = 4.88 S/m; $\varepsilon_r$ = 34.1; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5800 MHz; $\sigma$ = 5.09 S/m; $\varepsilon_r$ = 33.8; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 28.12.2012, ConvF(5.1, 5.1, 5.1); Calibrated: 28.12.2012, ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.76, 4.76, 4.76); Calibrated: 28.12.2012, ConvF(4.81, 4.81, 4.81); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

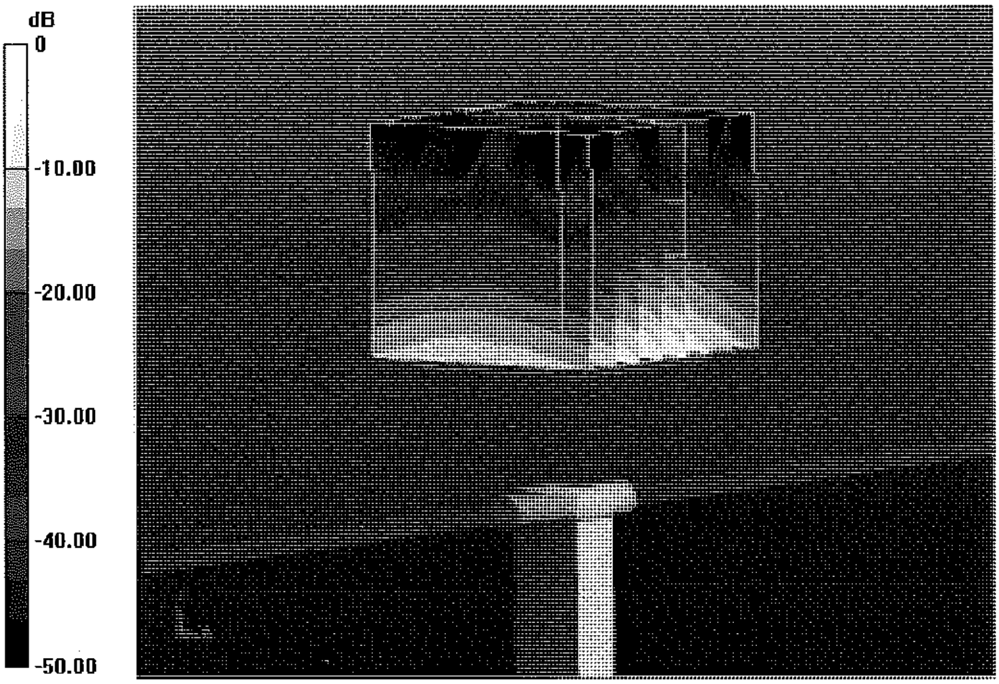
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.671 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 29.4 W/kg
**SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.17 W/kg**
Maximum value of SAR (measured) = 18.5 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.473 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 30.3 W/kg
**SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.22 W/kg**
Maximum value of SAR (measured) = 18.8 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.735 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 33.2 W/kg
**SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.28 W/kg**
Maximum value of SAR (measured) = 20.1 W/kg

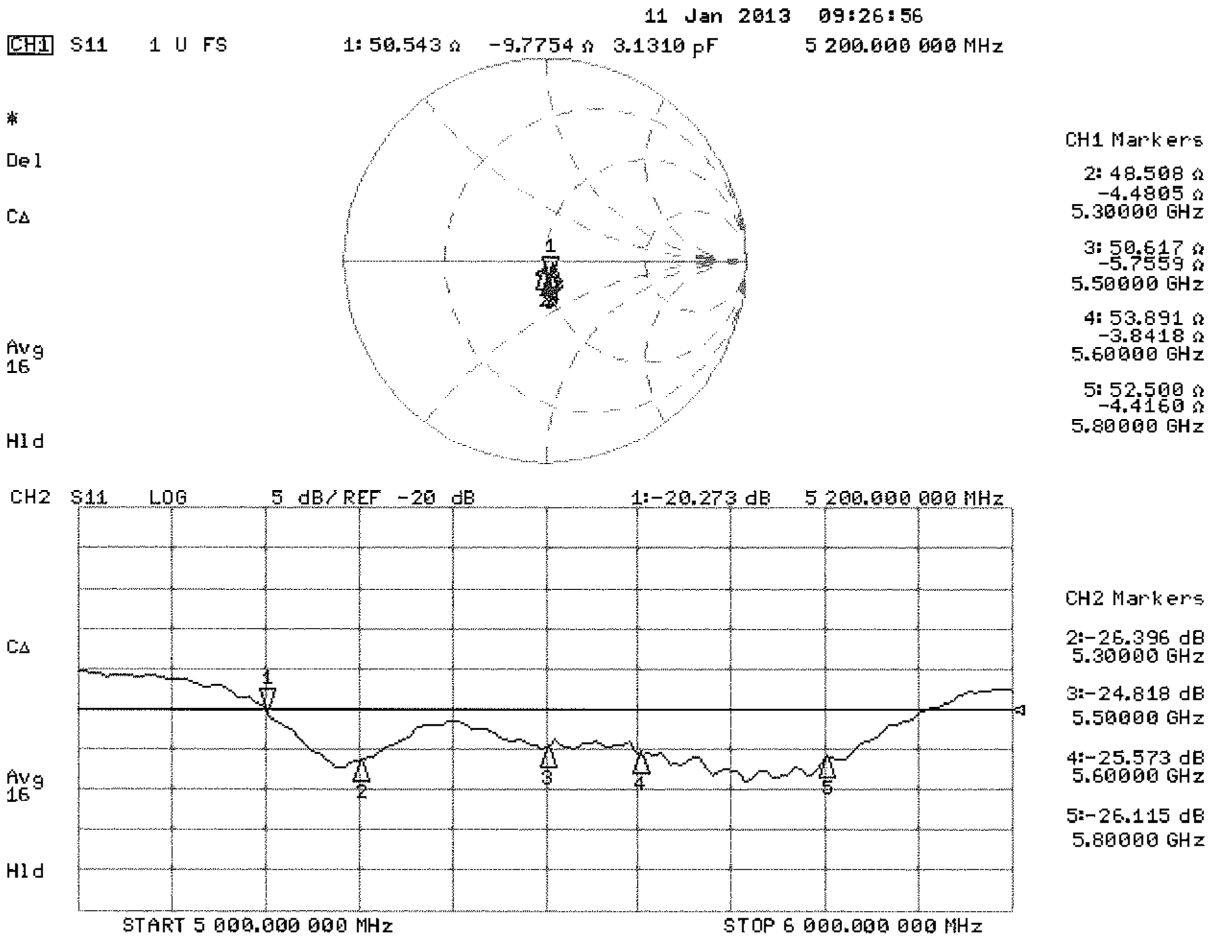
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.848 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 33.5 W/kg
**SAR(1 g) = 8.12 W/kg; SAR(10 g) = 2.3 W/kg**
Maximum value of SAR (measured) = 20.2 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 60.467 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 33.3 W/kg
**SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.17 W/kg**
Maximum value of SAR (measured) = 19.4 W/kg




0 dB = 19.4 W/kg = 12.88 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 10.01.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1057**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; $\sigma$ = 5.42 S/m; $\varepsilon_r$ = 47; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5300 MHz; $\sigma$ = 5.55 S/m; $\varepsilon_r$ = 46.8; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5500 MHz; $\sigma$ = 5.81 S/m; $\varepsilon_r$ = 46.5; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5600 MHz; $\sigma$ = 5.94 S/m; $\varepsilon_r$ = 46.3; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5800 MHz; $\sigma$ = 6.21 S/m; $\varepsilon_r$ = 46; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.67, 4.67, 4.67); Calibrated: 28.12.2012, ConvF(4.43, 4.43, 4.43); Calibrated: 28.12.2012, ConvF(4.22, 4.22, 4.22); Calibrated: 28.12.2012, ConvF(4.38, 4.38, 4.38); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

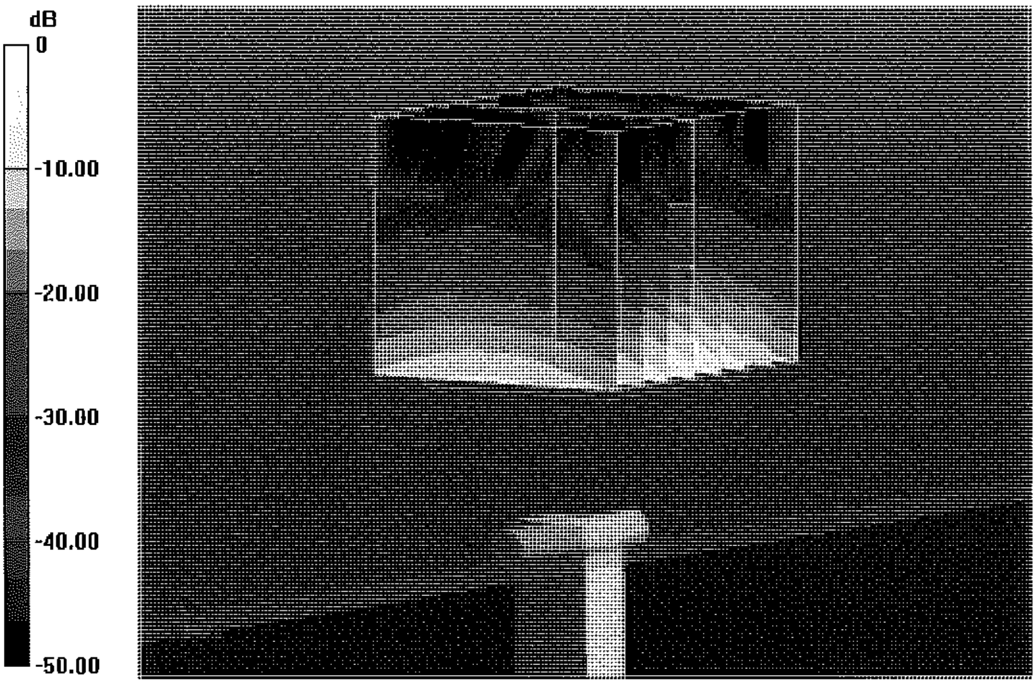
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.074 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 30.4 W/kg
**SAR(1 g) = 7.61 W/kg; SAR(10 g) = 2.13 W/kg**
Maximum value of SAR (measured) = 18.0 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.924 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 30.9 W/kg
**SAR(1 g) = 7.59 W/kg; SAR(10 g) = 2.13 W/kg**
Maximum value of SAR (measured) = 17.9 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 59.561 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 35.3 W/kg
**SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.26 W/kg**
Maximum value of SAR (measured) = 19.7 W/kg

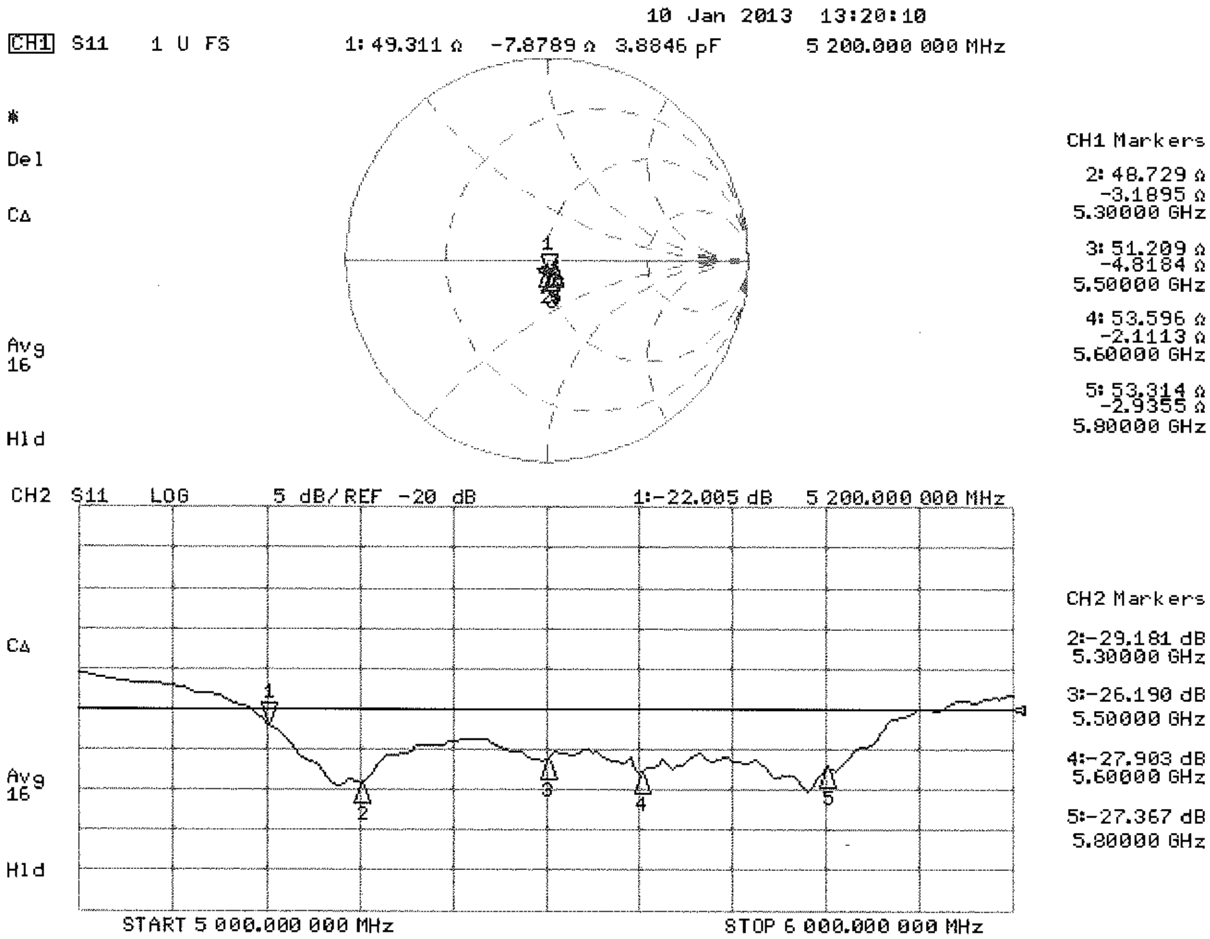
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.884 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 36.3 W/kg
**SAR(1 g) = 8.1 W/kg; SAR(10 g) = 2.25 W/kg**
Maximum value of SAR (measured) = 20.0 W/kg

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 55.753 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 35.6 W/kg
**SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.09 W/kg**
Maximum value of SAR (measured) = 18.9 W/kg




0 dB = 18.9 W/kg = 12.76 dBW/kg

### Impedance Measurement Plot for Body TSL



**Calibration Laboratory of**
Schmid & Partner
Engineering AG
**Zeughausstrasse 43, 8004 Zurich, Switzerland**

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**S** **Servizio svizzero di taratura**
**Swiss Calibration Service**

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

**Accreditation No.: SCS 108**

**Client** **PC Test**

**Certificate No: EX3-3589_Jan13**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3589 |
| Calibration procedure(s) | QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | January 17, 2013 |

✓ KK 1/28/13

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter E4419B | GB41293874 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 28-Dec-12 (No. ES3-3013_Dec12) | Dec-13 |
| DAE4 | SN: 660 | 20-Jun-12 (No. DAE4-660_Jun12) | Jun-13 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 17, 2013

## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C, D | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis |

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

# Probe EX3DV4

## SN:3589

Manufactured: March 30, 2006
Calibrated: January 17, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.46 | 0.40 | 0.40 | ± 10.1 % |
| DCP (mV)[B] | 100.5 | 103.8 | 99.6 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 165.8 | ±3.3 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 134.3 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 140.5 | |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of NormX,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 8.70 | 8.70 | 8.70 | 0.39 | 0.96 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 8.40 | 8.40 | 8.40 | 0.52 | 0.74 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.34 | 7.34 | 7.34 | 0.45 | 0.93 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.09 | 7.09 | 7.09 | 0.80 | 0.65 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.37 | 6.37 | 6.37 | 0.39 | 0.97 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.19 | 6.19 | 6.19 | 0.30 | 1.12 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 4.48 | 4.48 | 4.48 | 0.45 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.27 | 4.27 | 4.27 | 0.45 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.14 | 4.14 | 4.14 | 0.50 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 3.81 | 3.81 | 3.81 | 0.55 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 3.85 | 3.85 | 3.85 | 0.55 | 1.80 | ± 13.1 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

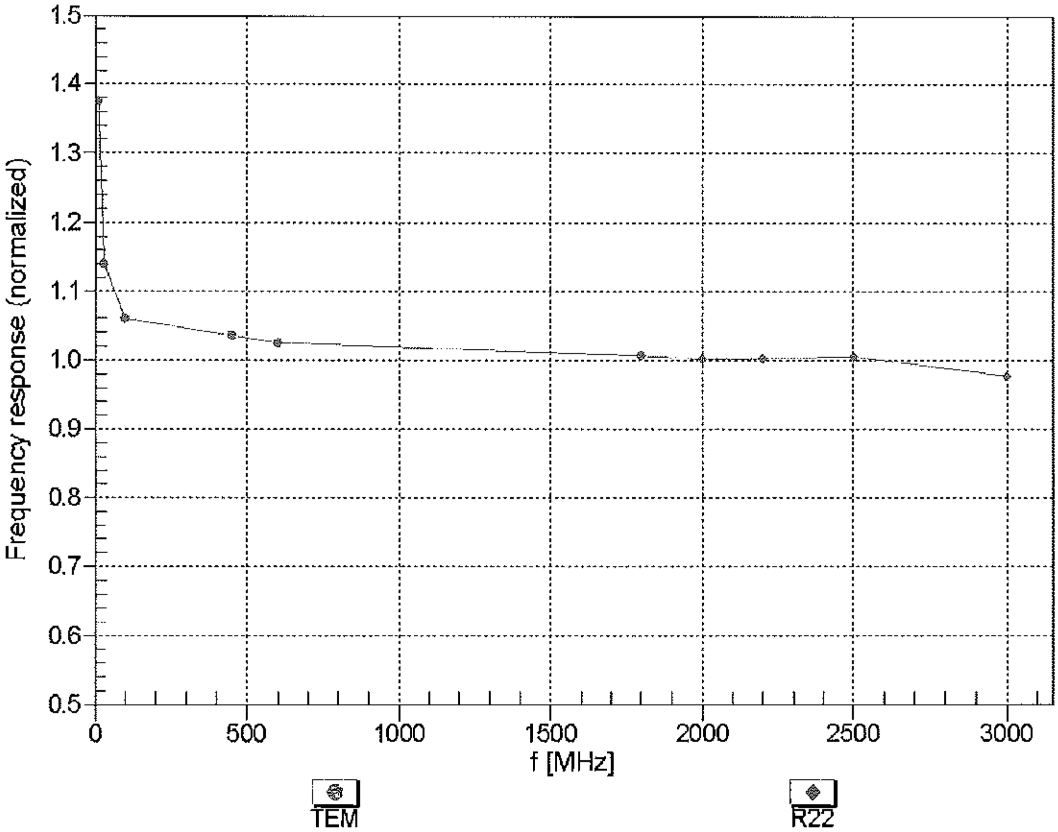
## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 8.59 | 8.59 | 8.59 | 0.49 | 0.86 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 8.43 | 8.43 | 8.43 | 0.38 | 1.05 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.87 | 7.87 | 7.87 | 0.44 | 0.89 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.46 | 7.46 | 7.46 | 0.58 | 0.75 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.07 | 7.07 | 7.07 | 0.80 | 0.50 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.68 | 6.68 | 6.68 | 0.80 | 0.50 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 3.99 | 3.99 | 3.99 | 0.50 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 3.81 | 3.81 | 3.81 | 0.50 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 3.52 | 3.52 | 3.52 | 0.55 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.32 | 3.32 | 3.32 | 0.60 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.66 | 3.66 | 3.66 | 0.60 | 1.90 | ± 13.1 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

# Frequency Response of E-Field

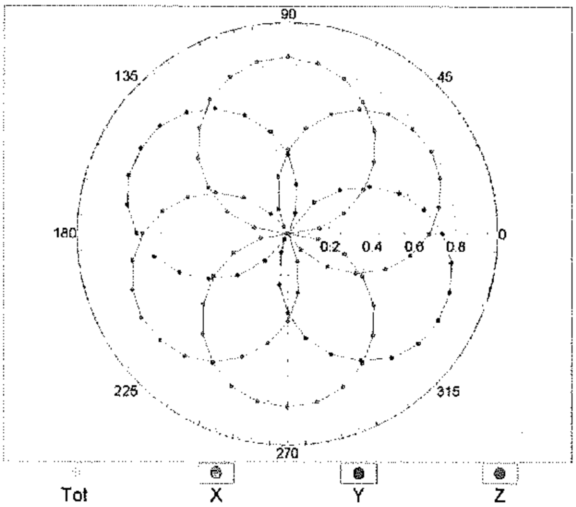
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**



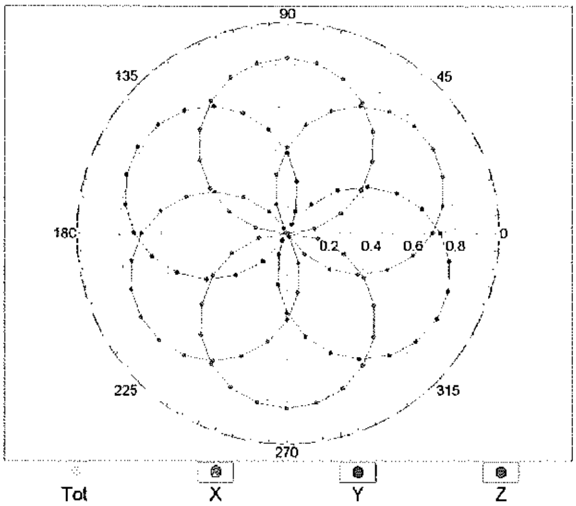

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

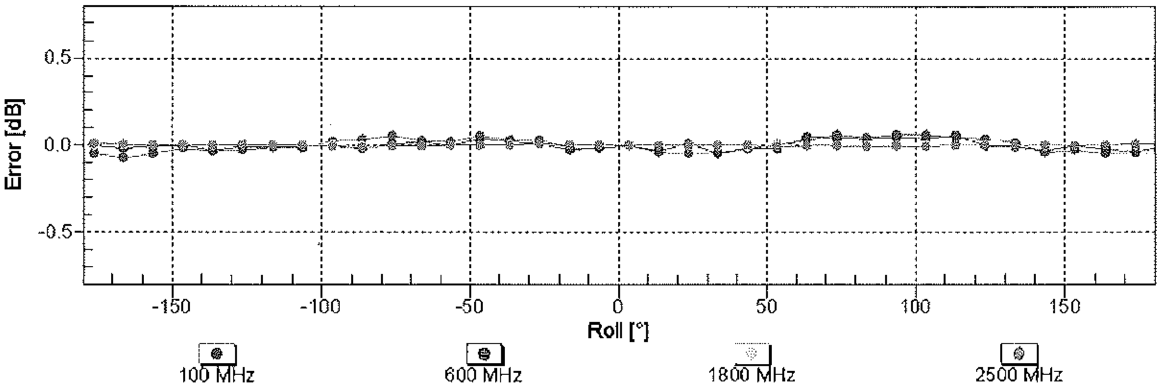
# Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



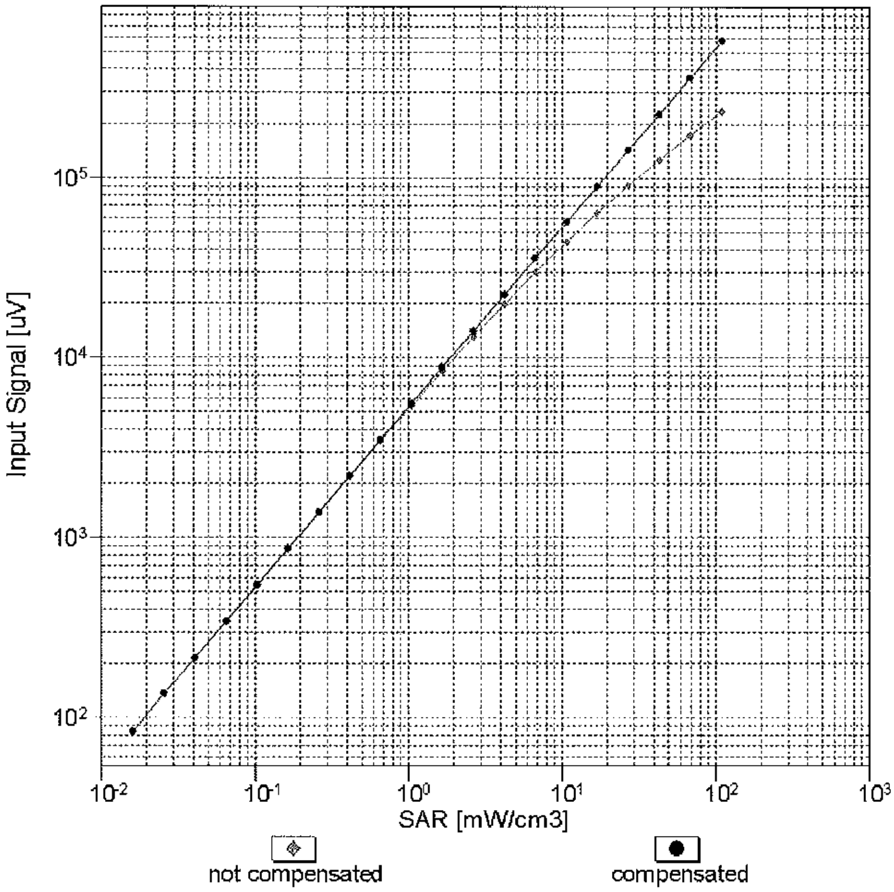

f=1800 MHz,R22

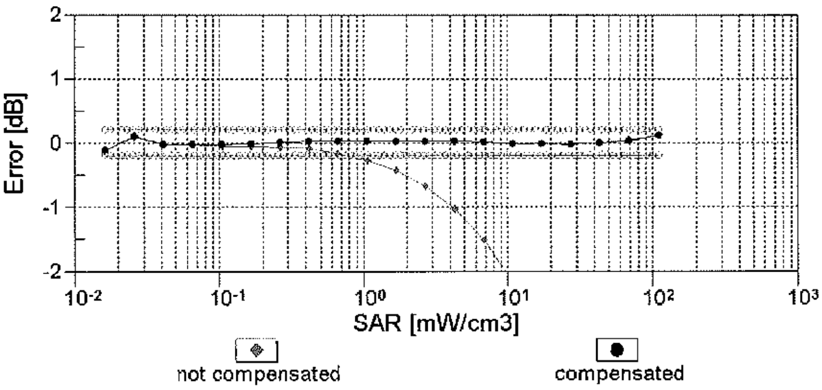



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

# Dynamic Range f($SAR_{head}$)
**(TEM cell , f = 900 MHz)**

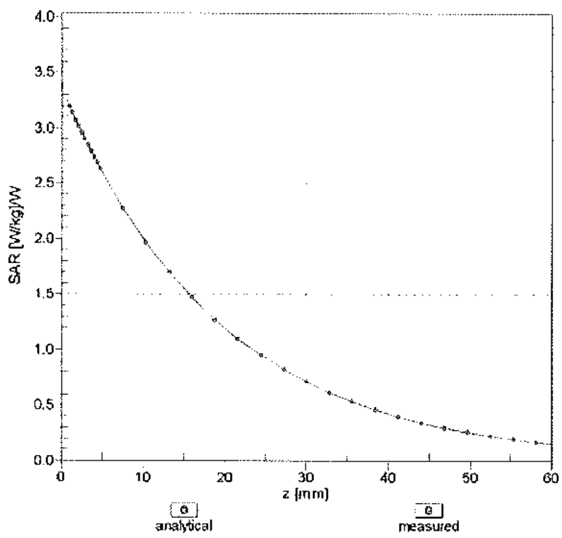


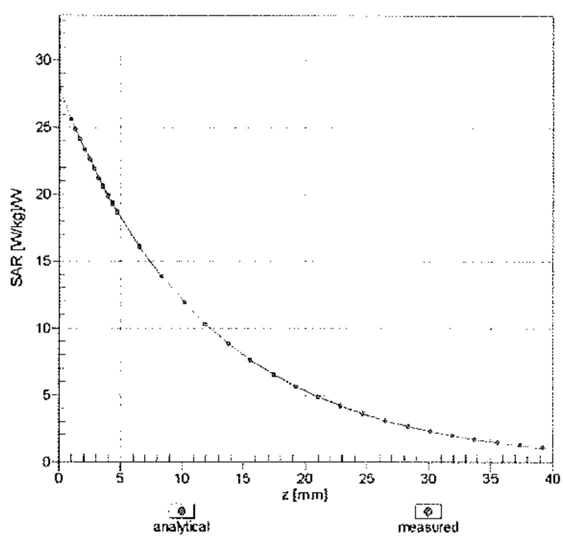

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

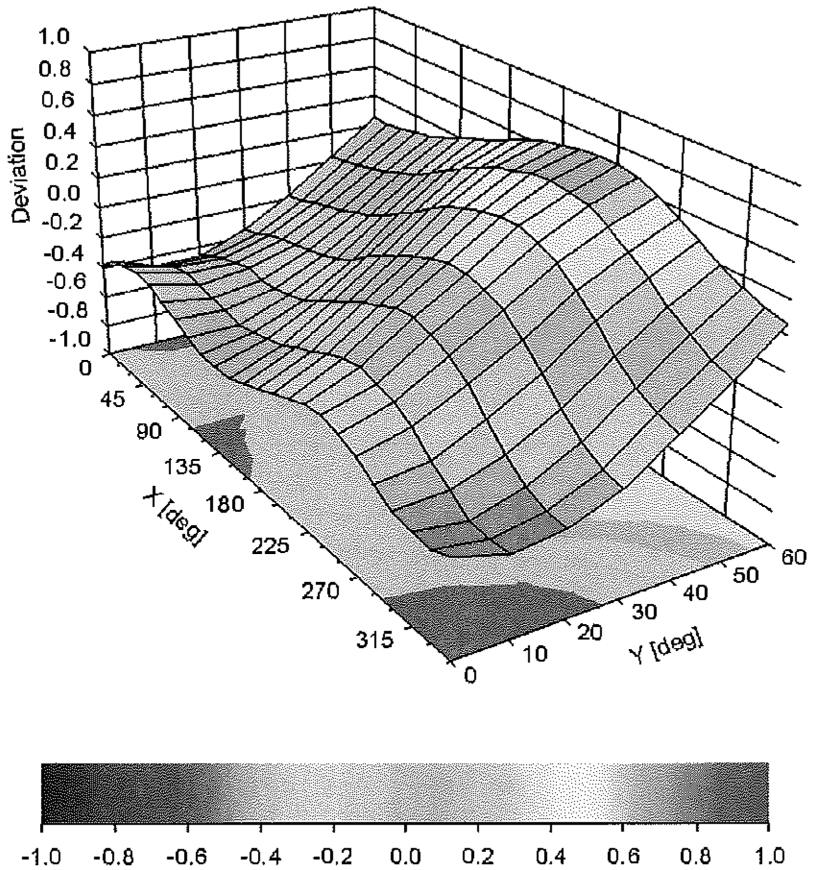



f = 1900 MHz,WGLS R22 (H_convF)




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




**Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)**

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -26.4 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 2 mm |

## APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue verification:

1) The network analyzer and probe system was configured and calibrated.
2) The probe was immersed in the tissue. The tissue was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
3) The complex admittance with respect to the probe aperture was measured
4) The complex relative permittivity $\varepsilon'$ can be calculated from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\varepsilon_r\varepsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp\left[-j\omega r(\mu_0\varepsilon_r'\varepsilon_0)^{1/2}\right]}{r} d\phi' d\rho' d\rho$$

where $Y$ is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$, $\omega$ is the angular frequency, and $j = \sqrt{-1}$.

**Table D-I**
**Composition of the Tissue Equivalent Matter**

| Frequency (MHz) | 5200-5800 | 5200-5800 |
|---|---|---|
| Tissue | Head | Body |
| Ingredients (% by weight) | | |
| Polysorbate (Tween) 80 | See Next Page | 20 |
| Water | | 80 |

## 2 Composition / Information on ingredients

The Item is composed of the following ingredients:

| | |
|---|---|
| Water | 50 – 65% |
| Mineral oil | 10 – 30% |
| Emulsifiers | 8 – 25% |
| Sodium salt | 0 – 1.5% |

**Figure D-1**
**Composition of 5 GHz Head Tissue Equivalent Matter**

**Note:** 5GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

**Measurement Certificate / Material Test**

| | |
|---|---|
| Item Name | **Head Tissue Simulating Liquid (HBBL3500-5800V5)** |
| Product No. | SL AAH 502 AB (Charge: 120402-2) |
| Manufacturer | SPEAG |

**Measurement Method**

TSL dielectric parameters measured using calibrated OCP probe (type DAK).

**Target Parameters**

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

**Test Condition**

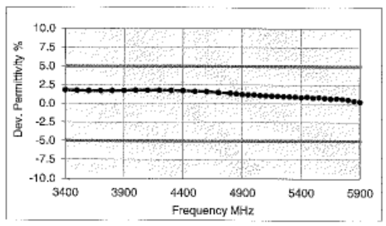
| | |
|---|---|
| Ambient Condition | 22°C ; 30% humidity |
| TSL Temperature | 22°C |
| Test Date | 4-Apr-12 |

**Additional Information**

| | |
|---|---|
| TSL Density | 0.985 g/cm$^3$ |
| TSL Heat-capacity | 3.383 kJ/(kg*K) |

**Results**

| | Measured | | | Target | | Diff.to Target [%] | |
|---|---|---|---|---|---|---|---|
| f [MHz] | HP-e' | HP-e'' | sigma | eps | sigma | Δ-eps | Δ-sigma |
| 3400 | 38.7 | 14.96 | 2.83 | 38.0 | 2.81 | 1.8 | 0.7 |
| 3500 | 38.6 | 14.91 | 2.90 | 37.9 | 2.91 | 1.7 | -0.3 |
| 3600 | 38.5 | 14.92 | 2.99 | 37.8 | 3.02 | 1.7 | -0.9 |
| 3700 | 38.3 | 14.92 | 3.07 | 37.7 | 3.12 | 1.7 | -1.5 |
| 3800 | 38.2 | 14.94 | 3.16 | 37.6 | 3.22 | 1.7 | -1.9 |
| 3900 | 38.1 | 14.95 | 3.24 | 37.5 | 3.32 | 1.7 | -2.4 |
| 4000 | 38.0 | 15.00 | 3.34 | 37.4 | 3.43 | 1.8 | -2.5 |
| 4100 | 37.9 | 15.04 | 3.43 | 37.2 | 3.53 | 1.8 | -2.8 |
| 4200 | 37.8 | 15.08 | 3.52 | 37.1 | 3.63 | 1.8 | -2.9 |
| 4300 | 37.7 | 15.14 | 3.62 | 37.0 | 3.73 | 1.8 | -3.0 |
| 4400 | 37.5 | 15.18 | 3.71 | 36.9 | 3.84 | 1.7 | -3.1 |
| 4500 | 37.4 | 15.20 | 3.81 | 36.8 | 3.94 | 1.6 | -3.3 |
| 4600 | 37.3 | 15.29 | 3.91 | 36.7 | 4.04 | 1.6 | -3.2 |
| 4700 | 37.1 | 15.34 | 4.01 | 36.6 | 4.14 | 1.5 | -3.2 |
| 4800 | 37.0 | 15.39 | 4.11 | 36.4 | 4.25 | 1.4 | -3.2 |
| 4850 | 36.9 | 15.43 | 4.16 | 36.4 | 4.30 | 1.3 | -3.1 |
| 4900 | 36.8 | 15.45 | 4.21 | 36.3 | 4.35 | 1.3 | -3.1 |
| 4950 | 36.7 | 15.47 | 4.26 | 36.3 | 4.40 | 1.2 | -3.1 |
| 5000 | 36.7 | 15.50 | 4.31 | 36.2 | 4.45 | 1.2 | -3.1 |
| 5050 | 36.6 | 15.55 | 4.37 | 36.2 | 4.50 | 1.1 | -3.0 |
| 5100 | 36.5 | 15.60 | 4.43 | 36.1 | 4.55 | 1.1 | -2.8 |
| 5150 | 36.4 | 15.62 | 4.48 | 36.0 | 4.60 | 1.0 | -2.8 |
| 5200 | 36.4 | 15.65 | 4.53 | 36.0 | 4.66 | 1.0 | -2.8 |
| 5250 | 36.3 | 15.67 | 4.58 | 35.9 | 4.71 | 1.0 | -2.8 |
| 5300 | 36.2 | 15.70 | 4.63 | 35.9 | 4.76 | 1.0 | -2.7 |
| 5350 | 36.1 | 15.70 | 4.67 | 35.8 | 4.81 | 0.9 | -2.9 |
| 5400 | 36.1 | 15.74 | 4.73 | 35.8 | 4.86 | 0.8 | -2.7 |
| 5450 | 36.0 | 15.75 | 4.77 | 35.7 | 4.91 | 0.9 | -2.8 |
| 5500 | 35.9 | 15.75 | 4.82 | 35.6 | 4.96 | 0.8 | -2.9 |
| 5550 | 35.9 | 15.80 | 4.88 | 35.6 | 5.01 | 0.8 | -2.7 |
| 5600 | 35.8 | 15.82 | 4.93 | 35.5 | 5.07 | 0.7 | -2.7 |
| 5650 | 35.7 | 15.86 | 4.98 | 35.5 | 5.12 | 0.7 | -2.6 |
| 5700 | 35.7 | 15.88 | 5.03 | 35.4 | 5.17 | 0.7 | -2.6 |
| 5750 | 35.6 | 15.90 | 5.08 | 35.4 | 5.22 | 0.6 | -2.6 |
| 5800 | 35.5 | 15.94 | 5.14 | 35.3 | 5.27 | 0.5 | -2.4 |
| 5850 | 35.4 | 15.98 | 5.20 | 35.3 | 5.34 | 0.4 | -2.5 |
| 5900 | 35.4 | 16.02 | 5.26 | 35.3 | 5.40 | 0.2 | -2.6 |



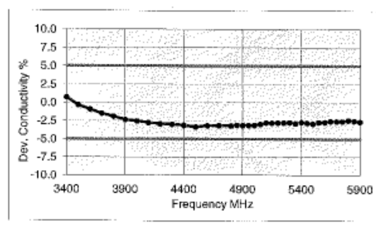




**Figure D-2**
**5GHz Head Tissue Equivalent Matter**

# APPENDIX E: SAR SYSTEM VALIDATION

Per FCC KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01 v01. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

**Table E-I**
**SAR System Validation Summary**

| SAR SYSTEM # | FREQ. [MHz] | DATE | PROBE SN | PROBE TYPE | PROBE CAL. POINT | | COND. | PERM. | CW VALIDATION | | | MOD. VALIDATION | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (σ) | ($\varepsilon_r$) | SENSI-TIVITY | PROBE LINEARITY | PROBE ISOTROPY | MOD. TYPE | DUTY FACTOR | PAR |
| A | 5200 | 1/24/2013 | 3589 | EX3DV4 | 5200 | Head | 4.659 | 35.55 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5300 | 1/24/2013 | 3589 | EX3DV4 | 5300 | Head | 4.800 | 35.40 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5500 | 1/24/2013 | 3589 | EX3DV4 | 5500 | Head | 5.004 | 34.83 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5800 | 1/24/2013 | 3589 | EX3DV4 | 5800 | Head | 5.392 | 34.17 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5200 | 1/23/2013 | 3589 | EX3DV4 | 5200 | Body | 5.292 | 47.85 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5300 | 1/23/2013 | 3589 | EX3DV4 | 5300 | Body | 5.477 | 47.47 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5500 | 1/23/2013 | 3589 | EX3DV4 | 5500 | Body | 5.729 | 47.03 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5800 | 1/23/2013 | 3589 | EX3DV4 | 5800 | Body | 6.233 | 46.20 | PASS | PASS | PASS | OFDM | N/A | PASS |

NOTE: All measurements were performed using probes calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01. SAR systems were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664.